JANUARY · 1956

# PETROLEUM REFINER

REFINING | PETROCHEMICALS | NATURAL GASOLINE

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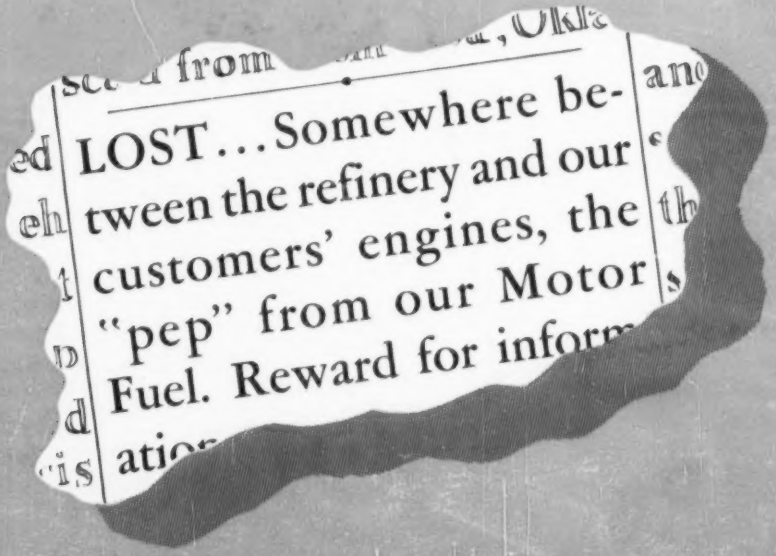
Maintenance Special Issue, Page 102

How's Your Cost? Page 103

New Data on $H_2S$ Corrosion, Page 124

Canada and Petrochemicals, Page 161

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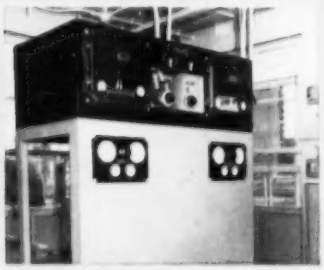
## TECHNICAL DATA

The Sinclair Refining Company's Plant in Hartford, Illinois is equipped with the Proportioneers TC-CRP, Type 500-45 Two Component Blender. It produces up to 500 barrels per hour of various asphalt cutbacks. The stream blender is arranged to blend an asphalt and diluent in a given predetermined ratio ranging from 90% asphalt and 10% diluent to 55% asphalt and 45% diluent. The diluents are naphtha for RC cutbacks and kerosene and distillates for MC and SC cutbacks. This system has a recirculation feature on each stream to allow a test run of the blender setting before actually blending products. It also has a Tally meter for presetting the required number of barrels needed in a batch and when the required batch is blended, the two streams return to recirculation.

Asphalt cutback stream blending at Sinclair Refining Company, Hartford, Illinois.



Close-up view of Model TC-CRP unit in control house shown above.

The stream blender uses positive displacement meters for measuring the two base products and the blended product. The meters give exceptionally high accuracy and very fine control over the entire range of asphalt cutbacks.

The system is equipped with remote stop and start positions at both tank truck and tank car loading racks. This feature makes it possible for one man to operate the blending plant and to do all the required loading.

# "STREAM BLEND" ASPHALTS FOR STREAMLINED HIGHWAYS

## THE PROBLEM:

Manufacturers of road oils and asphalt cutbacks recognize the blending of asphalt and cutter stock in open or vented tanks as a potential fire hazard. The present method of batch mixing an RC cutback by the addition of cold naphtha to hot asphalt results in high evaporation losses . . . while subsequent mechanical agitation produces an end product which requires reblending to produce the desired end viscosity. Material and time losses result. This is also true in MC and SC production, but to a lesser extent. The number of reblends required to produce the end viscosity depends entirely on the skill and experience of the operator.

## THE SOLUTION:

Continuous, automatic in-line blending of asphalt and cutter stock . . . with after-cooling where necessary . . . produces a stable end product of predetermined viscosity in a single pass . . . directly to mobile equipment. This system eliminates any fire hazard . . . loss of time and materials . . . and the need for redoping and subsequent mixing. It also cleans up the operation, increases efficiency, and assures economical operation. A single operator . . . with stream blending . . . can reproduce any blend required by the adjustment of one master ratio control.

## Features:

- ★ *Streamlined Operation*
- ★ *In-line Mixing*
- ★ *No Loss of Light Fractions*
- ★ *No Fire Hazard*
- ★ *High Capacity*
- ★ *Cleanliness*
- ★ *Minimum Inventory*
- ★ *Flexibility*

**"THE BEST COSTS LESS"**

Our experience in engineering, manufacture, and service of complete blending systems is at your disposal.
Send us data on your problem for prompt analysis and recommendations.
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Volume 35, No. 1 January, 1956

PETROLEUM
# REFINER
REFINING | PETROCHEMICALS | NATURAL GASOLINE

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# A Quick Look
## at This Maintenance Issue

**Maintenance Cost Summary**

These results of an industry-wide cost survey show you for the first time what is being spent for maintenance *as a percentage of product value.* Also shown: What will be invested for equipment to do the job of one man. Stores and spares inventory value are included. See how your operation compares with these averages and trends. Turn to **Page 103.**

☐ **How Effective Is Your Maintenance Dollar?** Here is Part One, of three, on this question. Included are suggestions on how you can use current reports to learn much about your maintenance operation. This is first hand dope from the firing line. Keep up to date and tear this for reference. Turn to **Page 104.**

☐ **How to Avoid Power Failures** . . . Here is the result of a plan started forty years ago to improve electrical equipment performance. You can put many of these pointers to good use in your plant. The rapid increase in the amount of electrical gear in use makes the subject most important. Turn to **Page 108.**

☐ **Exchanger Preventive Maintenance Pays** . . . Get an inside look at teamwork and how it has paid off in preventive maintenance—also firsthand information on the up-to-date methods being used by Union Oil at Wilmington. Don't miss these valuable tips, turn to **Page 111.**

☐ **Planned Refinery Maintenance** . . . Here is the way engineering control, along with good organization and complete records, is applied to the sizable maintenance job at the Kent Refinery of The British Petroleum Company. Take this opportunity to see how it is being done . . . turn to **Page 115.**

☐ **Maintenance Needs Engineers** . . . The growing need for maintenance engineers is yet to be recognized in many plants. For a complete description of the need for—and importance of—engineers in mechanical and maintenance departments, turn to **Page 120.**

☐ **Preventive Maintenance of Process Pumps** . . . Here is the story on actual comparative

→ Now Turn the Page →

## A Quick Look at This Issue

experience in pump maintenance. Results show that preventive maintenance cuts costs to a half or less. Learn how and why so you can save money on your pump maintenance. Turn to **Page 121.**

☐ **How to Reduce Hydrogen Attack** . . . You get the story on Humble's experience in finding ways to limit hydrogen attack. Here is the complete picture on what causes the trouble and what can be done about it. Bring yourself up-to-date with this result of six years operating experience. Turn to **Page 124.**

☐ **How to Reduce Compressor Downtime** . . . Here's a check list of the many points you can use to reduce downtime through preventive maintenance. It starts with design and follows through installation and operation. Save time and money in your compressor operation with these tips. Turn to **Page 129.**

☐ **Here's How Baharain Is Maintained** . . . Many interesting insights into the problems of overseas refinery maintenance are given. The importance of good planning, training and human relations is emphasized. Take a look at the way they do it. Turn to **Page 133.**

☐ **You Can Cut Your Blower Maintenance Costs** . . . Here are some good tips on getting better service and lower maintenance on your rotary blower installations. Improve your knowledge of this type equipment and what makes it tick. Turn to **Page 136.**

☐ **Planning Pays in Turbine Maintenance** . . . Here are the ways Dow at Freeport, Texas, gets 97.3 percent availability from turbine units. Good planning and organization do the trick. To get the most out of your machines take advantage of this experience. Turn to **Page 140.**

☐ **Preventive Maintenance for Power Relays and Circuit Breakers** . . . Here is the story of Sohio's solution to costly outages caused by faulty relay coordination. As more electrical equipment is installed your chances of trouble increase unless you take similar preventive steps. Turn to **Page 144.**

☐ **What Happens in $H_2$ - $H_2S$ Corrosion** . . . For those concerned with reformers and other hydrogen processes, here is some of the most important information of the year. This is the first comprehensive corrosion evaluation of steel, low Cr alloy and Cr-Ni-alloy in $H_2S$ - $H_2$ atmospheres at elevated temperature. These data will help you solve some of your tough corrosion problems. And you can save some money in materials selection. Turn to **Page 147.**

☐ **Take a Look at 1956** . . . Demand for oil products will parallel the general economy, a 4½ percent increase being expected in the U. S. Outside this country the demand will gain even more. See **Page 152.**

☐ **Heat Exchanger Design Part 4—Mechanical Design** . . . The concluding article in this series on heat exchanger design covers all phases of mechanical design. The author presents calculating procedures for designing tubes, shell, tube sheets, floating head cover, channel and shell covers, and flanges. **Page 155.**

☐ **Petrochemicals in Canada** . . . The progress of the Petrochemical industry in Canada is shown from its inception in 1943 up to the present time. For the story of the development of this industry in the three industrial centers of Canada turn to **Page 161.**

☐ **Thermodynamics for Process Evaluation** . . . These simplifications to the principles of thermo will help you to evaluate processes easily and quickly. No integration is required. The thermo terms are given practical meaning. The resulting evaluation will give direction to operation improvement efforts. **Page 165.**

☐ **Carbon Formation in Cat Cracking** . . . A method is developed to estimate the effect of charging rate, process period and temperature on the quantity of carbon deposited on the catalyst. Also, a way is given to use fixed bed reactor data for estimating results with the same catalyst and charge in moving bed or turbulent fluidized reactors. Take advantage of these evaluation aids given on **Page 169.**

☐ **Compressor Cylinders without Cooling?** . . . Two years experience in operating gasoline plants without the use of jacket water in compressor cylinders has convinced Sinclair there is no measurable loss in gas handling capacity and no increase in cylinder wear. On all new installations this company has discontinued the use of cooling water on cylinders, saving installation cost of pumps, headers, and cylinder water piping. Also, water usage has been reduced. **Page 174.**

☐ **$560 Million Postwar Expansion Program** . . . This is what The British Petroleum Company has spent to meet the demand for oil products since World War II. For the colorful story of a company that emerged from the destruction of war to expand its refining activity into seven countries, turn to **Page 100.**

☐ **Accounting Is An Effective Tool** . . . The success or failure of maintenance accounting depends on the attitude of the people involved. Here is a suggested program that will help improve the interdepartmental relations of any company. Turn to **Page 229.**

☐ **Improved Human Relations** . . . Ability to get along with people is a vital factor in modern industry. For a graphic description of the importance Monsanto places on human relations in maintenance, and for some ideas which may apply in your company, turn to **Page 235.**

☐ **Operations-Maintenance Coordination** . . . Looking for ways to improve relations between your operation and maintenance departments? You may find the answer in the coordination program outlined by Brea Chemical on **Page 241.**

# PETROLEUM REFINER

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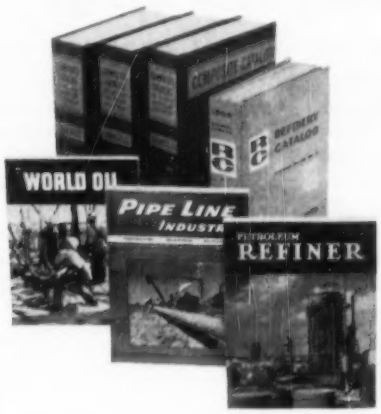



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PIPE LINE INDUSTRY for the oil and gas pipe line industry

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## Special Starts '56

WE'VE ARRANGED an extra special special start for our readers this year. This takes the form of 15 extraordinarily valuable articles dealing with maintenance that you will find commencing on Page 102. These 15 articles occupy the bulk of our editorial pages this month and comprise our annual Maintenance Issue. No matter what your field—refining, petrochemical or natural gasoline operations, you will be interested. We're saying that with some confidence because we all know that maintenance is the prime variable cost in all petroleum industry plant operations. And who isn't interested in studying costs?

## Et Tu Boskohu-Gijutsu!

Interest in articles published by PETROLEUM REFINER is widespread and if we ever had any doubt about that fact, M. Hanada's letter of November 15 would help to set us straight.

Mr. Hanada, connected with The Nippon Corrosion Engineering Company, Ltd., cathodic protection engineers of Tokyo, Japan, read W. B. Brooks' "Seawater as an Industrial Coolant" (PETROLEUM REFINER, October and November, 1954) whereupon he hankered to translate it. This done, he sought and received permission to publish it (and here's where we got our item heading) in "Boskohu-Gijutsu" or "Corrosion Engineering." B-G is a monthly report of the committee for Preventing Corrosion of the Japanese Society for the Promotion of Science.

We hope the members of the Society, even as Mr. Hanada says he did, "find it very interesting." And helpful, too, we might add.

## Other People's Mail

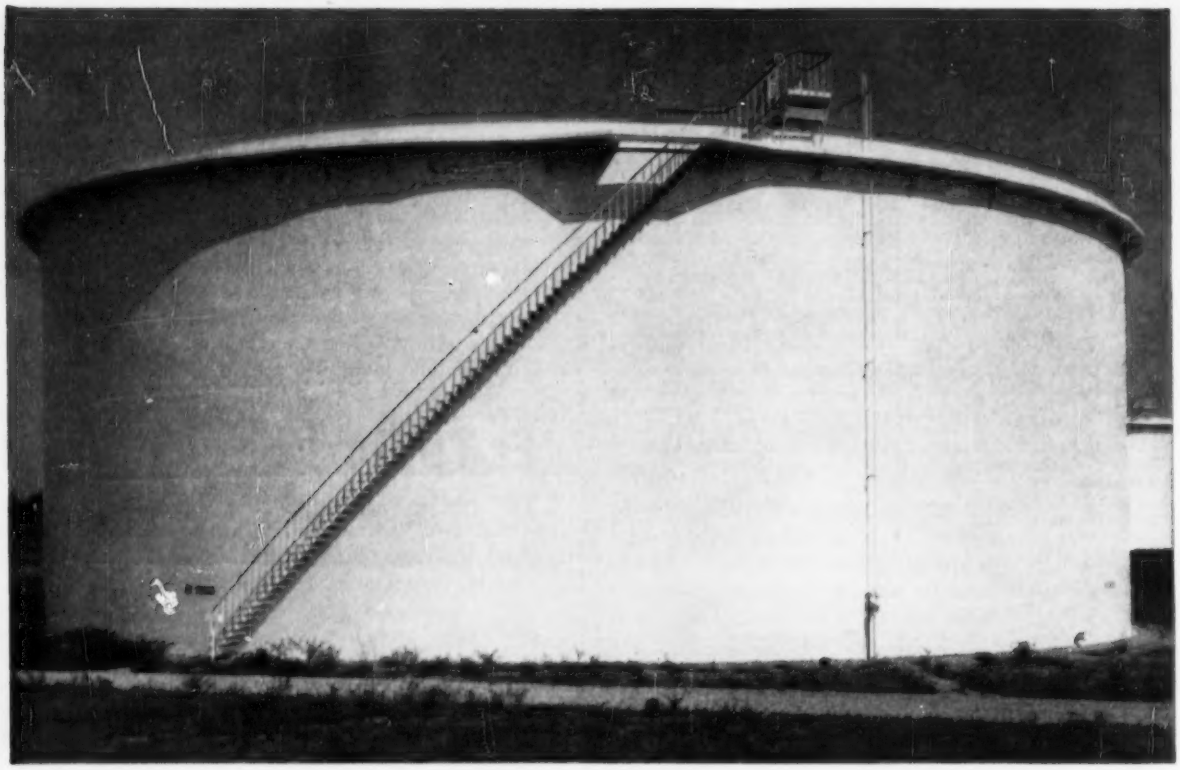
YOU WILL FIND of interest this month certain design discussions appearing in "The Mail Box." Turn to Page 85 and get in on this valuable back-and-forth talk. Your letters always get our quick attention and when appropriate, and you're agreeable, find themselves in this regular department.

## For the Asking

THERE ARE A COUPLE of useful items that PETROLEUM REFINER is offering free for the asking:

One is the new Author's Handbook, a compendium of highly useful and practical information for the technical man who writes or hopes to some day. Several hundred have been distributed since the revised edition became available in November. Could you use one? Just write us.

Two is the Annual Index of PETROLEUM REFINER editorial material during the year 1955. Heretofore this has been bound into the December issue, but this year it is available only as a separate. Requests should be addressed to Librarian, Box 2608, Houston 1, Texas.



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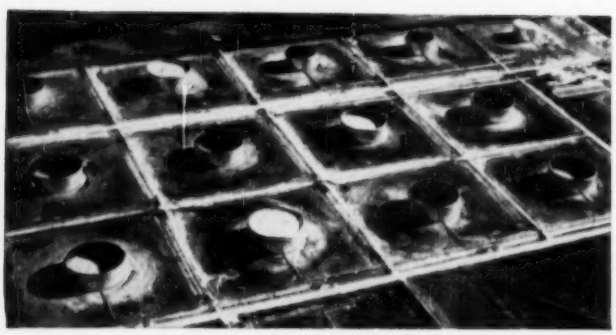

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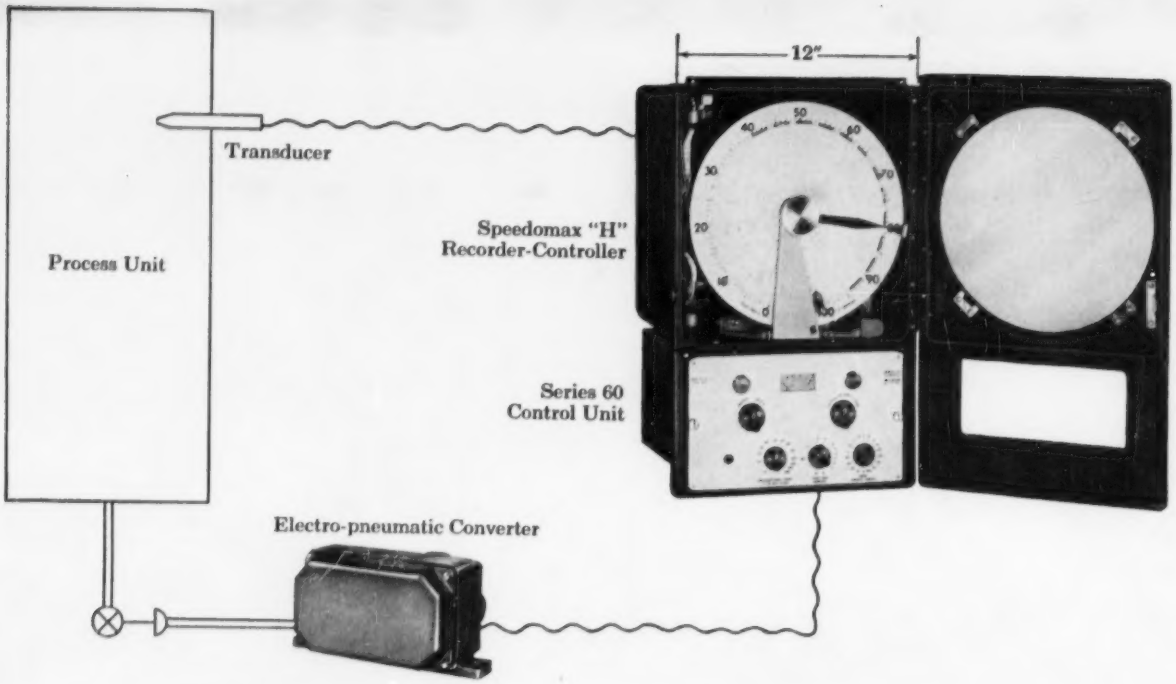


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# gives you these advantages:

- **FAST ELECTRICAL RESPONSE in measurement, control, transmission.**
- **SIMPLICITY, LOW COST, ADAPTABILITY and the special safety of pneumatic operation.**
- **EASY INSTALLATION with only 1 pair of leadwires from the control unit to the converter mounted near the process; then short air lines from converter to valve.**

L&N's C. A. T. (Current-adjusting type) Control combines the advantages of pneumatic valve operation with the flexibility and fast response of an electrical control system. The electrical signal produced by a change in the process variable passes from transducer, to Speedomax recorder, to L&N Control Unit. Here, the properly tuned combination of proportional, rate, and reset actions produces a control current which is fed to the Electro-pneumatic Converter. The Converter matches the control characteristics of the current output with an air pressure which operates the pneumatic valve.

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The force-balance type Electro-pneumatic Converter is ideal for installation directly on the process unit. It can be mounted anywhere, in any position; is vibration-resistant and weather-proof. Its minute (5 milliamp) current and continuous air purge provide a wide safety margin for operation in hazardous areas. If power fails or the control unit is removed, the control valve is sealed in its last position. And the Converter is so sensitive that its dead band is less than 0.1%.

C. A. T. Electro-pneumatic Control may well be the answer to your control needs. For details, write for Folder ND4(8). The address—Leeds & Northrup Co., 4923 Stenton Ave., Phila. 44, Pa.

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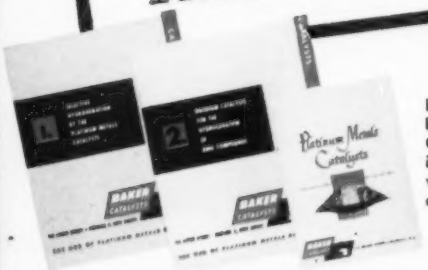
If you would like detailed information on Baker Catalysts and our Catalyst Recovery Service, your inquiry will receive our immediate attention. ★ ★ ★ ★




Literature on Platinum Metals Catalysts is available and will be sent at once, upon request.

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**The Wm. Powell Company, Cincinnati 22, Ohio . . . 110th YEAR**

PERFORMANCE PV VERIFIED

FIG. 1503—150-Pound Steel Gate Valve.

FIG. 6003—Steel Gate Valve for 600 Pounds W.S.P.

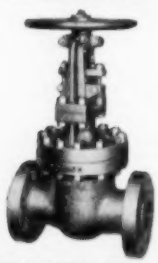
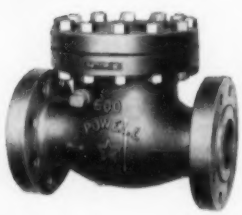


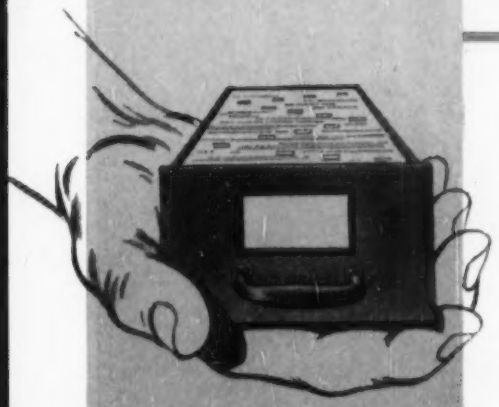
FIG. 6061—600-Pound Steel Swing Check Valve.



# POWELL VALVES

BRONZE, IRON, STEEL AND CORROSION RESISTANT VALVES.

*With Our Experience*



# We think we can find the answer to your refinery tubing problems

Maybe we sound confident. But why not? Our tubing specialists have been meeting and solving refinery tubing problems for over 60 years—problems that deal with corrosion, oxidation, acids, high and low temperatures, pressures, exposures, etc. These case histories have been kept on file, and can be tapped for information at any time.

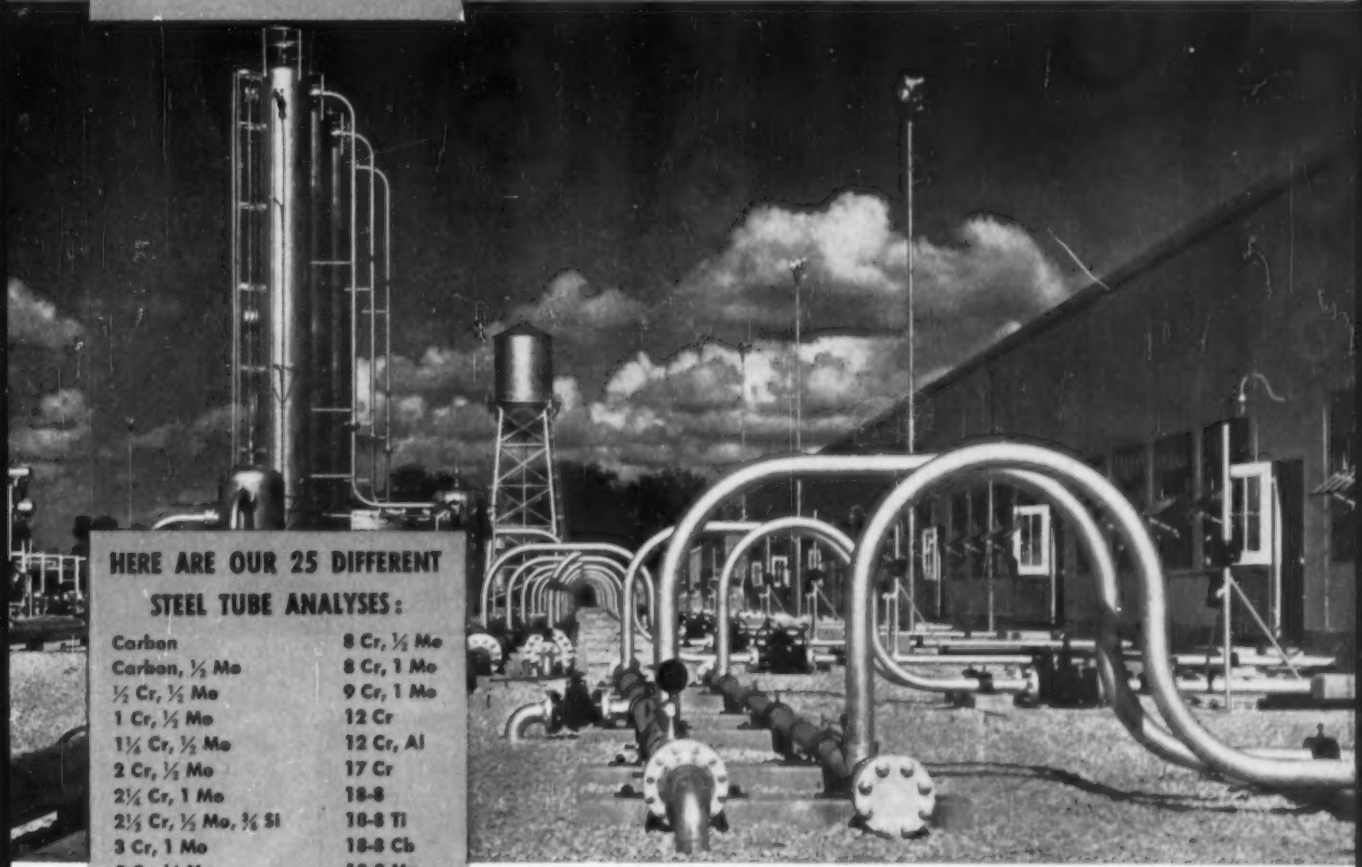
We've used this 60-year-experience file to develop the list of 25 steel analyses shown here. Each analysis was specifically-designed to combat certain refinery conditions, and each one has been tested time and again so that we know its exact capabilities and limitations. Other chemical compositions are also available in tubular products, and a wide variety of high temperature problems are now under study.

So you see why we feel confident to tackle any refinery tubing problem that comes along. Why not send us yours today?

Write to National Tube Division, United States Steel Corporation, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

**National Tube Division, United States Steel Corporation, Pittsburgh, Pa.**
**(Tubing Specialties)**

COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO, PACIFIC COAST DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK



**HERE ARE OUR 25 DIFFERENT STEEL TUBE ANALYSES:**

| | |
|---|---|
| Carbon | 8 Cr, ½ Mo |
| Carbon, ½ Mo | 8 Cr, 1 Mo |
| ½ Cr, ½ Mo | 9 Cr, 1 Mo |
| 1 Cr, ½ Mo | 12 Cr |
| 1¼ Cr, ½ Mo | 12 Cr, Al |
| 2 Cr, ½ Mo | 17 Cr |
| 2¼ Cr, 1 Mo | 18-8 |
| 2½ Cr, ½ Mo, ¾ Si | 18-8 Ti |
| 3 Cr, 1 Mo | 18-8 Cb |
| 5 Cr, ½ Mo | 18-8 Mo |
| 5 Cr, ½ Mo, 1½ Si | 25-20 |
| 7 Cr, ½ Mo | 3½ Ni |
| 9 Ni | |

WELLS WITHOUT WELDS

# NATIONAL SEAMLESS PIPE AND TUBES

USS

UNITED STATES STEEL

# How to pick the 1 tubing steel out of 24 to give you longest tube life per dollar

## *Ask the experts!*

OF THE 24 different high-temperature tube steels the Timken Company offers to solve your heat, pressure, corrosion and oxidation problems, *one* analysis is most exactly suited to your particular needs, to give you maximum tube life per dollar of cost.

To find this analysis, *ask the experts.*

These experts are the metallurgists of The Timken Roller Bearing Company. The benefit of their more than 20 years of steel research and experience—with emphasis on high-temperature steels—is yours for the asking. They'll help you select the analysis that will give you longest tube life for your money—the only true measure of actual tube steel cost.

Whichever analysis you choose, you can be confident of uniform quality. The Timken Company maintains rigid quality control from melt shop through final inspection.

Why not let the Timken Company's metallurgists help pick the tubing steel that can solve *your* problem? *Ask the experts!* The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

*This month's report is on:*

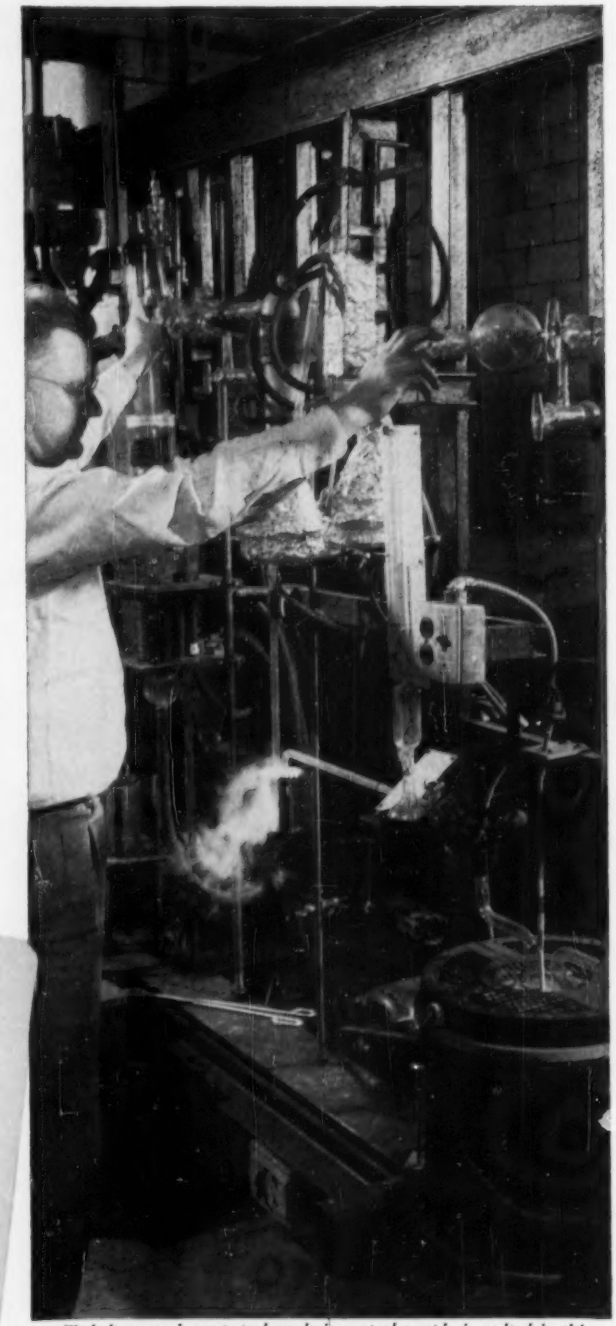
### 18-8 STAINLESS

An austenitic, non-magnetic alloy that shows the best combination of creep strength, oil corrosion resistance and oxidation resistance for service up to 1500°F. For use in oil cracking systems, hydrogenation equipment, high temperature oil and steam piping, superheater elements, heat exchangers.

**ONE OF 24 TIMKEN HIGH TEMPERATURE STEELS**

| | | | |
|---|---|---|---|
| Carbon | Sicromo 2 | Sicromo 5S | 18-8Ti |
| Carbon-Mo. | Sicromo 2½ | Sicromo 5MS | 16-13-3 |
| DM-2 | 2½% Cr.-1% Mo. | Sicromo 7 | 25-20* |
| Silmo | Sicromo 3 | Sicromo 9M | 25-12* |
| DM | 4-6% Cr.-Mo. | 18-8 Stainless | 35-15** |
| 2% Cr.-Mo. | 4-6% Cr.-Mo.-Ti | 18-8 Cb | 16-25-6** |

* *Available as seamless tubing on an experimental basis only.*
** *Not available as seamless tubing.*



*To help control exact steel analysis, a steel sample is melted in this vacuum fusion apparatus. Then gases are pumped out, and the amount present in the steel is determined.*

YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

**SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING**

# THE MOST POWERFUL GASOLINE LOSES ITS POWER WITHOUT THESE ADDITIVES

# Tenamene

**EASTMAN GASOLINE ADDITIVES**

Protecting the performance of gasoline are the gum-inhibiting Tenamenes. Protecting the performance of the Tenamenes are the care in manufacture and the interested technical service of our petroleum specialists who are ready to help solve your refinery inhibitor problems on the spot.

*For more information on Tenamene additives and the service that backs up their proper use, contact our local representative or write to Eastman Chemical Products, Inc., Kingsport, Tennessee—a subsidiary of Eastman Kodak Company.*

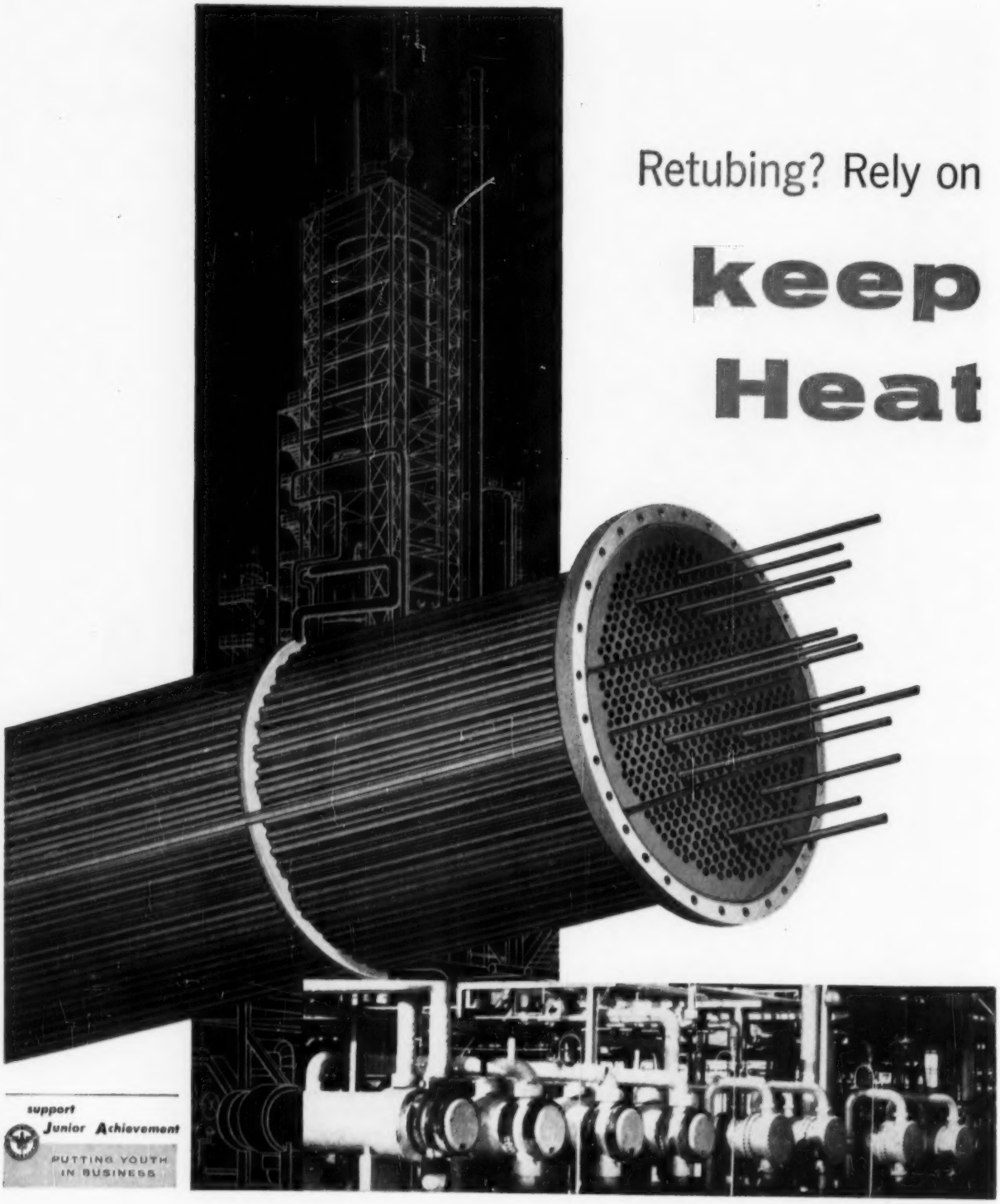
**SALES OFFICES: Eastman Chemical Products, Inc.,** Kingsport, Tennessee; New York—260 Madison Ave.; Framingham, Mass.—65 Concord St.; Cincinnati—Carew Tower; Cleveland—Terminal Tower Bldg.; Chicago—360 N. Michigan Ave.; St. Louis—Continental Bldg.; Houston—412 Main St. **West Coast: Wilson Meyer Co.,** San Francisco—333 Montgomery St.; Los Angeles—4800 District Blvd.; Portland—520 S. W. Sixth Ave.; Salt Lake City—73 S. Main St.; Seattle—821 Second Ave.



For more data on advertised products, use Readers' Service Cards, last page.

Retubing? Rely on

# keep Heat



support Junior Achievement
PUTTING YOUTH IN BUSINESS

*First for Lasting Quality—from Mine to Market!*

Phelps Dodge COPPER-BASE ALLOY Tubes to

# your Exchangers On-Stream!

- ✓ **Complete line of copper-base alloys** including Bi-Metal combinations to meet special corrosive conditions.
- ✓ **Speedy delivery** from strategically-located warehouses.
- ✓ **Careful analysis of your corrosion problems** by experienced engineering staff.
- ✓ **Quality-controlled fabrication** to assure finest tube properties.
- ✓ **Information and sales service** available from nearest Phelps Dodge district office.*

PHELPS DODGE COPPER PRODUCTS CORPORATION

*SALES OFFICES: Atlanta, Birmingham, Ala., Boston, Buffalo, Charlotte, Chicago, Cincinnati, Cleveland, Dallas, Detroit, Fort Wayne, Greensboro, N. C., Houston, Jacksonville, Kansas City, Mo., Los Angeles, Milwaukee, Minneapolis, New Orleans, New York, Philadelphia, Pittsburgh, Portland, Ore., Richmond, Rochester, N. Y., San Francisco, St. Louis, Seattle, Washington, D. C.

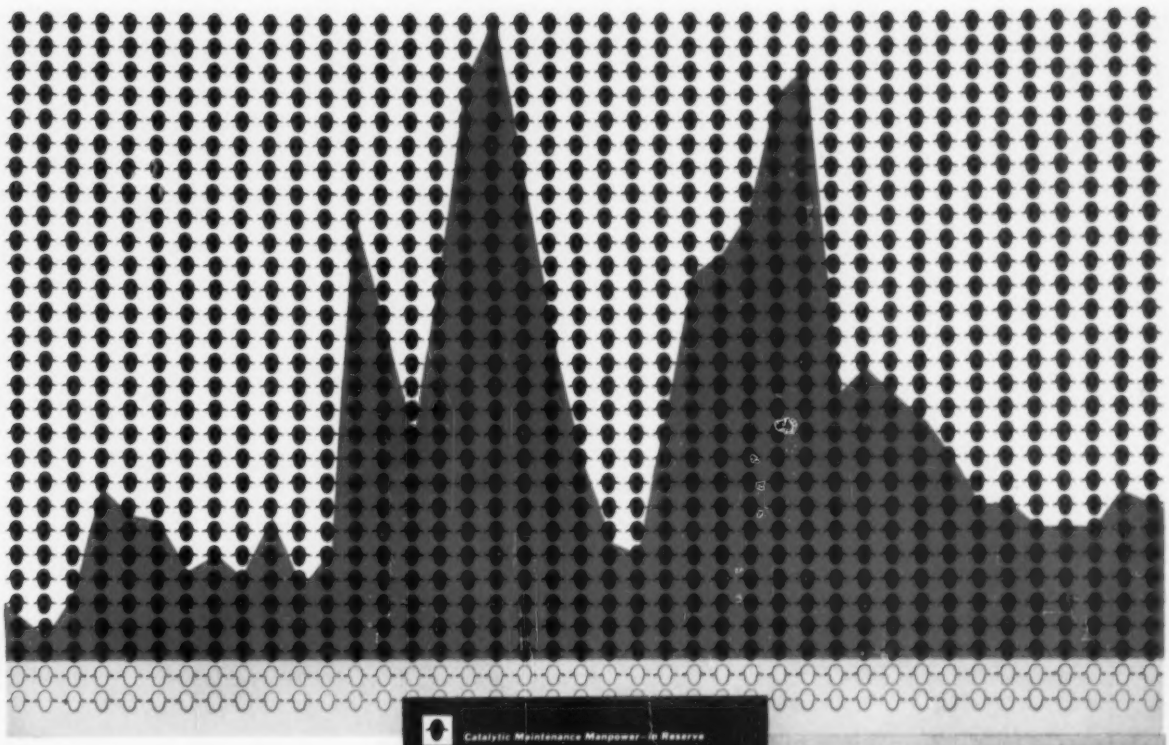
# How B&W Hollow Forgings Solve Engineering and Production Problems

- The Engineer can specify materials closer to the most desirable design requirements because of the large range of sizes and materials offered in B&W Hollow Forgings.
- The problem of maintaining production schedules is made easier due to good delivery on both large and small quantities.
- B&W Hollow Forgings of the specified analysis produced from initial electric furnace melting under carefully controlled conditions are high-quality forgings that —in use—mean savings in time and cost.
- Because the outside surface of every B&W Hollow Forging is machined, the surface finish and appearance are superior and the user's fabrication cost is sharply reduced.
- Special design requirements can be met; special shapes, special end preparations such as end closures, reduced diameter, flanges and the like.
- To get the *complete* picture of what B&W Hollow Forgings offer you, send for the new B&W Hollow Forgings Bulletin, S-16B. The Babcock & Wilcox Company, Process Equipment Department, Barberton, Ohio.

BABCOCK & WILCOX

BOILER DIVISION

S-445




## HOW HIGH ARE your MAINTENANCE COSTS?

This graph of the actual maintenance manpower load of an operating facility demonstrates how *Catalytic's Maintenance Contract Service* can lower production costs in modern process plants.

Catalytic's flexible supporting work force responds to peak-and-valley manpower needs.

This service provides . . .

- Stabilization of plant employment . . .
- Additional skilled labor when needed . . .
- Release of management from costly supervision of non-profit phases of the operation . . .
- Easier control of maintenance costs . . .
- Measurable savings in dollars.

Whether you want to assure minimum maintenance manpower costs in an operating plant . . . or to establish flexible, economical maintenance in a new plant . . . you will find helpful facts, backed by years of experience, in our new booklet, "Production at Lowest Net Operating Cost." May we send you a copy?

# CATALYTIC

**CONSTRUCTION COMPANY**

**1528 Walnut Street, Philadelphia 2, Pennsylvania**

**In Canada:**

**Catalytic Construction of Canada, Ltd.; Sarnia, Ontario**

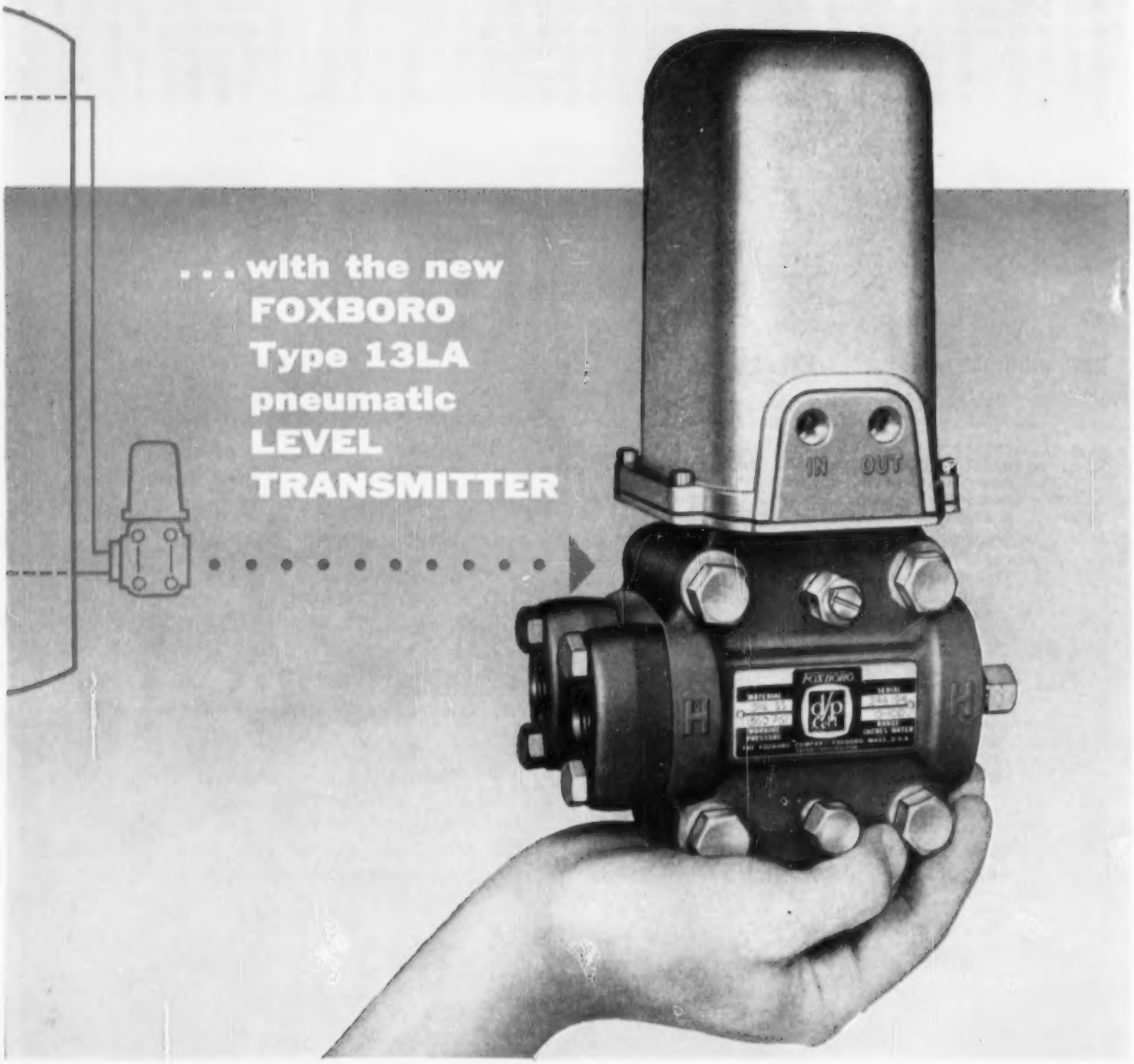
**CATALYTIC ON-TIME . . . ON-BUDGET SERVICES for the atomic energy, chemical, petrochemical and oil refining industries • Project Analysis • Process Design • Economic Studies • Engineering • Procurement • Construction • Plant Operation**



For more data on advertised products, use Readers' Service Cards, last page.

NEW SIMPLICITY

FOR LIQUID LEVEL







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# MEASUREMENT !

**Easy Low-Cost Installation** on any closed or open tank. Only two small pressure taps required. Nothing inside tank!

**Fully-Adjustable Ranges** . . . 0-20" to 0-80" and 0-50" to 0-250" $H_2O$.

**Complete adjustment** for elimination of outside leg effect gives forward-reading signal to any standard receiver!

**Highest Sustained Accuracy** . . . Instant, precise response to level changes even under extreme operating conditions.

**Rugged and Corrosion-Resistant** . . . Level-sensing element is Type 316 stainless steel, silicone-filled "capsule" diaphragm applicable on static pressures up to 1500 lbs.

There's nothing simpler for accurately measuring liquid level than the Foxboro Type 13LA d/p Cell* Liquid Level Transmitter! No floats, knife edges, stuffing boxes, or complicated hook-ups. A simple, direct piping job connects it to the tank . . . operates in any position, even upside down. The Transmitter precisely measures difference in head caused by level change . . . sends 3-15 psi air signal over single air line to indicator, recorder, or controller. It's easily traced when required, up to 250°F., to maintain fluidity of liquid.

The 13LA d/p Cell Transmitter is low in initial cost, requires practically no maintenance. In addition, it is easily converted in field for the measurement of fluid flow. It's the ideal instrument for heavy industrial applications . . . indoors or out. For complete details, ask your nearest Foxboro Sales Engineer, or write for new Bulletin 13-22 to **The Foxboro Company, 741 Neponset Ave., Foxboro, Mass., U.S.A.** *Reg. U. S. Pat. Off.

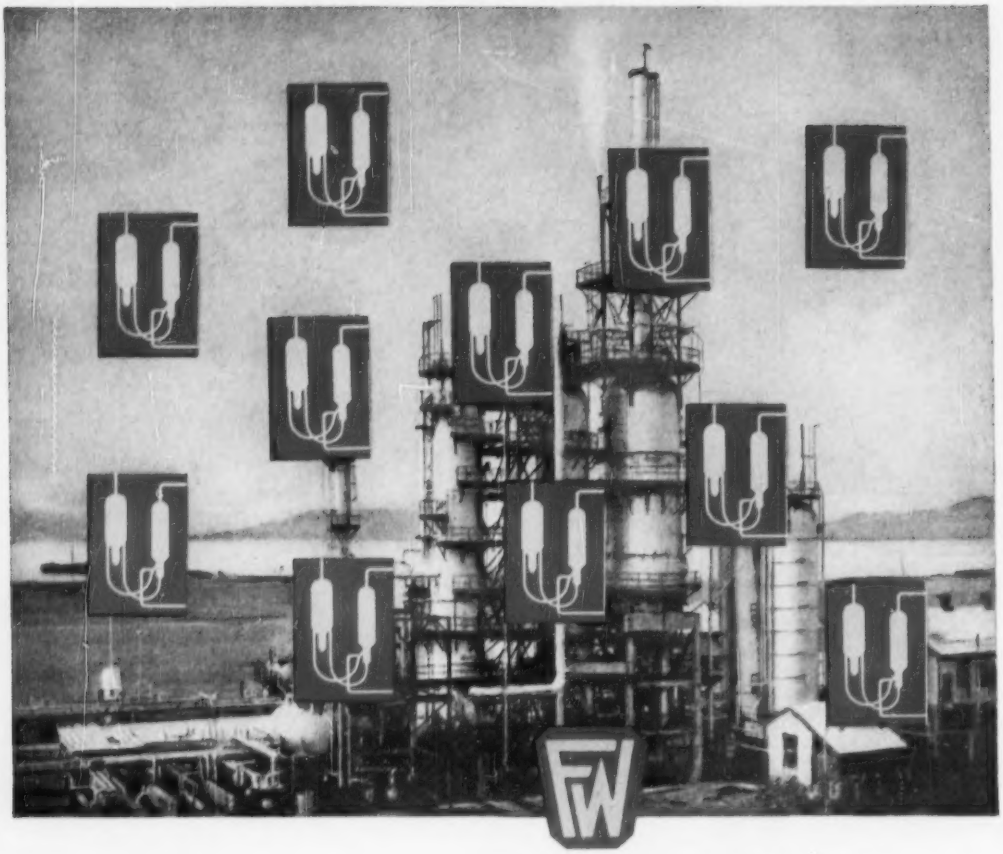
FACTORIES IN THE UNITED STATES, CANADA, AND ENGLAND

FOXBORO
REG. U. S. PAT. OFF.

LIQUID LEVEL TRANSMITTER




For more data on advertised products, use Readers' Service Cards, last page.




# eleven

## Model IV Fluid Catalytic Cracking Units... by Foster Wheeler

THE Model IV Fluid Catalytic Cracking Process, developed by The Esso Research and Engineering Company, is in operation throughout the worldwide petroleum industry. Foster Wheeler has designed and constructed Model IV plants in Canada, India, France, Australia, The Philippines and Indonesia.

This FW know-how in fluid catalytic cracking process design and construction can help you get higher octane fuels on stream faster, at lowest possible cost. We will be glad to quote on your requirements. *Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.*

**FOSTER WHEELER**

NEW YORK • LONDON • PARIS • ST. CATHARINES, ONT



For more data on advertised products, use Readers' Service Cards, last page.

How Zeolite System at Public Service Company of Colorado

# "Irons Out"

## Water Irregularities Caused by Fluctuating Loads

**DENVER'S UNUSUAL CLIMATE** causes unusual water conditioning problems at Public Service Company of Colorado's Zuni Station. Steam from this station is used to heat downtown Denver buildings. Denver's balmy midday climate — except in the two cold months of the year—is the cause of troublesome load fluctuations.

The lime-soda-phosphate system installed in this plant by Allis-Chalmers in 1949 was one of the most modern in the country at the time. It is ideal for extremely high loads in the morning and evening, but requires careful adjustment to handle the low loads around noon.

Public Service of Colorado has decided to modernize to take advantage of developments in "hot lime–hot zeolite" systems since the original installation. The zeolite part of the system acts as its own corrective when loads drop, "ironing out" hardness irregularities in the lime effluent and eliminating need for manual adjustments. The new system will provide more consistent operation and lower hardness. The only chemicals needed are lime and salt, holding operating costs to a minimum.

The changeover, being handled completely by Allis-Chalmers, consists of adding zeolite softeners to the original equipment furnished by A-C.

Next time you have a water problem — or want to consider modernization — take advantage of Allis-Chalmers water conditioning experience. For information, call the A-C office nearest you or write Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

# ALLIS-CHALMERS

**WATER CONDITIONING—CHEMICALS, EQUIPMENT, SERVICE—FOR OVER 25 YEARS**

A-C ALLIS-CHALMERS

A-4844

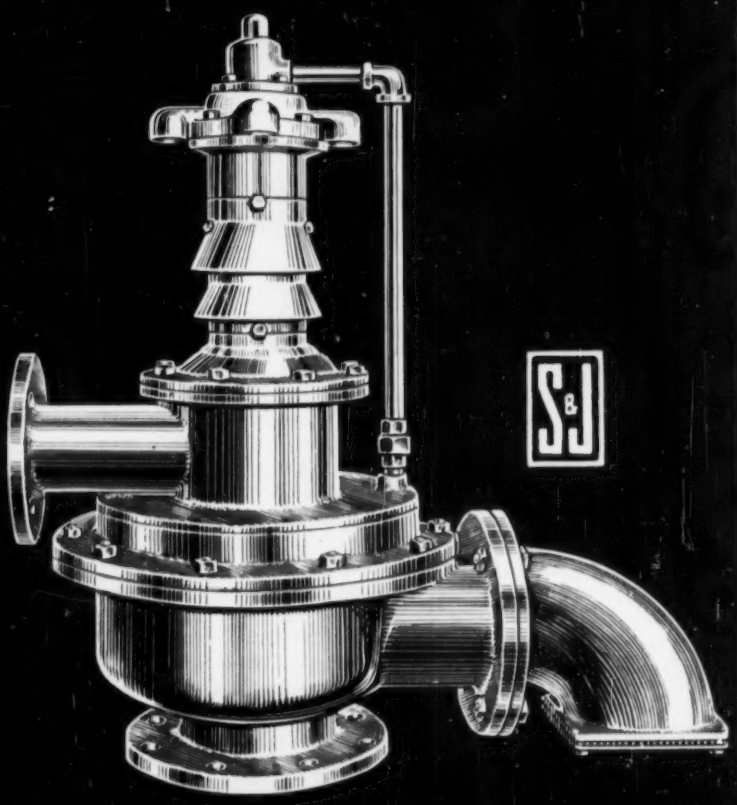



For more data on advertised products, use Readers' Service Cards, last page.

# IMPORTANT INSURANCE

A TRULY efficient safety relief valve for pressure storage tanks must remain tightly closed at all pressures within the working range, yet must open without fail whenever internal tank pressure tends to exceed the working limit. The Shand & Jurs Pilot Operated Safety Valves meet these specifications to a "T." They provide the important insurance against property damage and personnel hazards caused by failures due to excessive internal tank pressures.

The S&J Pilot Operated Safety Valve, Fig. ST-5000, incorporates a special seal on the main valve pallet preventing any leakage prior to full opening. It operates exactly at the set pressure with a minimum of blowdown, requiring no accumulation of pressure above this setting for full opening. A special "peeling action" on valve seating surfaces minimizes interference by freezing or sticky foreign substances. Should the diaphragms be damaged or ruptured, the valve will continue to operate at a lower pressure. Available in 4" and 6" sizes for pressure ranges of 1 to 10 pounds.




Shand and Jurs Co.
BERKELEY 10, CALIFORNIA

NEW YORK
342 Madison Ave.

HOUSTON
M & M Bldg.

TULSA
Thompson Bldg.

CHICAGO
10409 S. Western Ave.

LOS ANGELES
6399 Wilshire Blvd.

REPRESENTATIVES:
SEATTLE: Nebar Supply Company, 3000 Western Avenue
MONTREAL: Lytle Engineering Specialties, Ltd., 360 Notre Dame St., W
TORONTO: Lytle Engineering Specialties, Ltd., 85 Richmond St., W.
VANCOUVER: P. D. McLaren & Son, Ltd., 3277 Main Street
CARACAS: Sinclair Spence, C.A., Edificio Galipan
ENGLAND: Whessoe, Ltd., Sales: 25 Victoria St., London, S.W. 1
Whessoe, Ltd., Works: Darlington, County Durham

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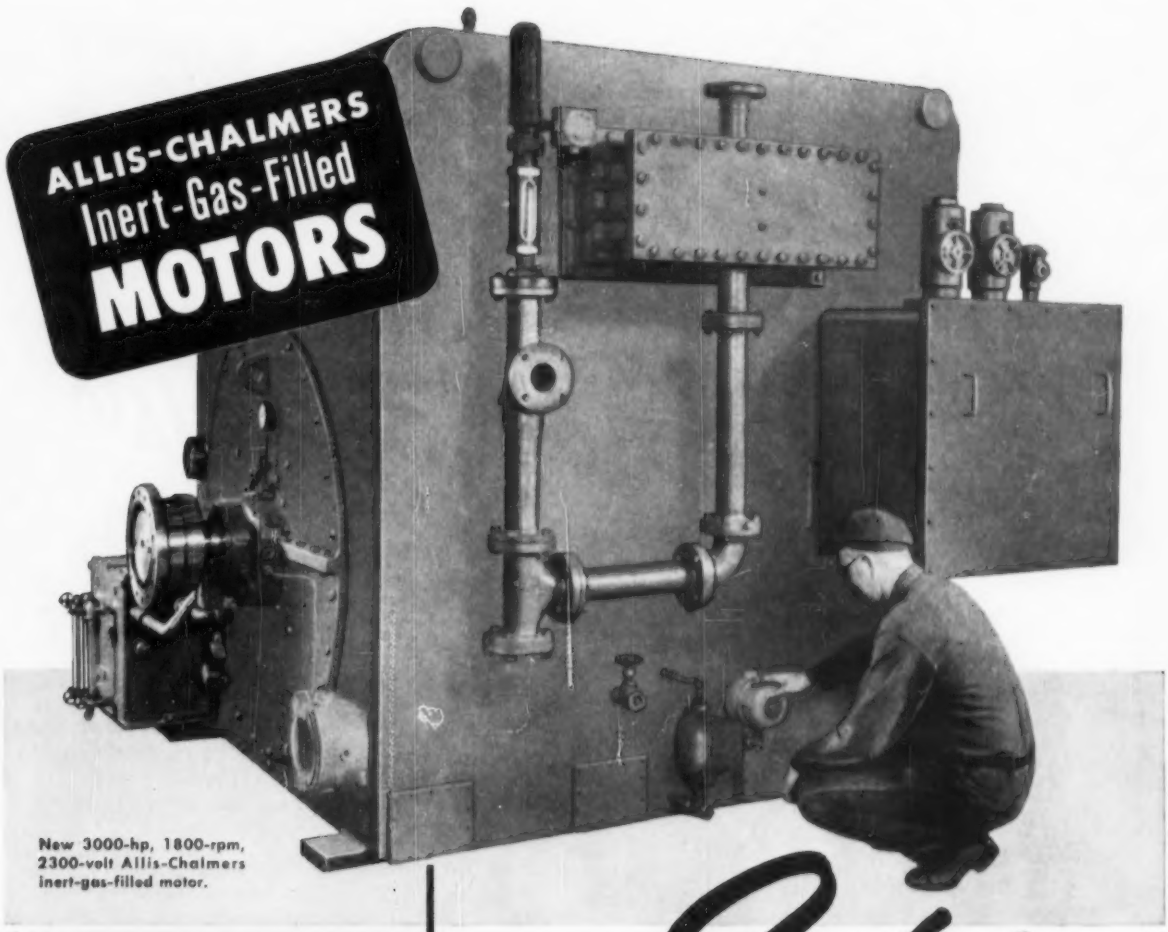
ALLIS-CHALMERS
Inert-Gas-Filled
MOTORS



New 3000-hp, 1800-rpm, 2300-volt Allis-Chalmers inert-gas-filled motor.

# For Hazardous Areas

# Get *Safety* with Economy!

**These motors have been found ideal for driving high speed compressors in refineries.** An inert-gas atmosphere is maintained inside the enclosure of the motor. The non-explosive gas is held under positive pressure and keeps out volatile surrounding gases that could cause an explosion.

Air-to-water surface heat exchangers remove heat of motor losses. Special oil seals on shaft extension prevent gas leakage outward along the shaft.

These motors are available in a wide range of ratings in larger sizes. Ask the A-C office in your district, or write to Allis-Chalmers, Power Equipment Division, Milwaukee 1, Wisconsin.

A-C ALLIS-CHALMERS

**ALLIS-CHALMERS**

A-4825



For more data on advertised products, use Readers' Service Cards, last page.

# Catalysts

## Require stability, too . . .

and with Davison's *LOW DENSITY* catalyst you get commercially proven higher stability. You get a higher degree of thermal stability without affecting the resistance to attrition or other proven qualities of Davison catalysts. Commercial fluid cracking units, operating for over one year, demonstrate that this stability leads to:

**Higher surface area—Higher pore volume—Higher pore diameter—Higher catalytic activity—Improved regeneration**

This new *LOW DENSITY* catalyst is yet another Davison catalyst manufactured with controlled catalyst characteristics. At Davison you can get the catalyst best suited for your unit. For information on Davison's new *LOW DENSITY* catalyst, as well as other Davison catalysts, see your Davison representative or write.

*Progress Through Chemistry*

**DAVISON CHEMICAL COMPANY**

*Division of W. R. Grace & Co.*

**Baltimore 3, Maryland**

**Sales Offices: Chicago, Ill.; Houston, Tex.; New York, N. Y.; Baltimore, Md.**
**In Canada: Davison Chemical Company Ltd., Toronto**

PRODUCERS OF: CATALYSTS, INORGANIC ACIDS, SUPERPHOSPHATES, TRIPLE SUPERPHOSPHATES, PHOSPHATE ROCK, SILICA GELS AND SILICOFLUORIDES. SOLE PRODUCERS OF DAVCO® GRANULATED FERTILIZERS.



For more data on advertised products, use Readers' Service Cards, last page.

There's MORE rating selection available in Allis-Chalmers MOTORS

To meet refinery needs... Allis-Chalmers Offers Complete Line of Rib-Type Motors from 1 to 100 Hp

Made to order for refinery use, Allis-Chalmers explosion-proof, rib-type motors are available in ratings from 1 to 100 hp. The many cost-saving features of deep-rib construction can be applied in a variety of uses... both indoors and out.

*Here's why these motors can cut refinery costs:*

**MORE cooling surface**
Rib-type design provides reserve cooling capacity in dirty locations.

**MORE iron**
Cast-iron frame and external parts assure rigidity and resistance to corrosion.

**MORE copper**
A-C's greater use of copper increases electrical life.

**MORE lubrication provisions**
Provision made for in-service relubrication — important where corrosive vapors contaminate grease.

As a new machinery component or as replacement, specify Allis-Chalmers. To find out more, contact your nearby Allis-Chalmers distributor, district office, or write Allis-Chalmers, General Products Division, Milwaukee 1, Wisconsin.

A-4896

ALLIS-CHALMERS

# ALCOA Alumina is still one of industry's "best buys"

*Despite sharply rising costs, ALCOA's prices remain uniformly low since 1915*

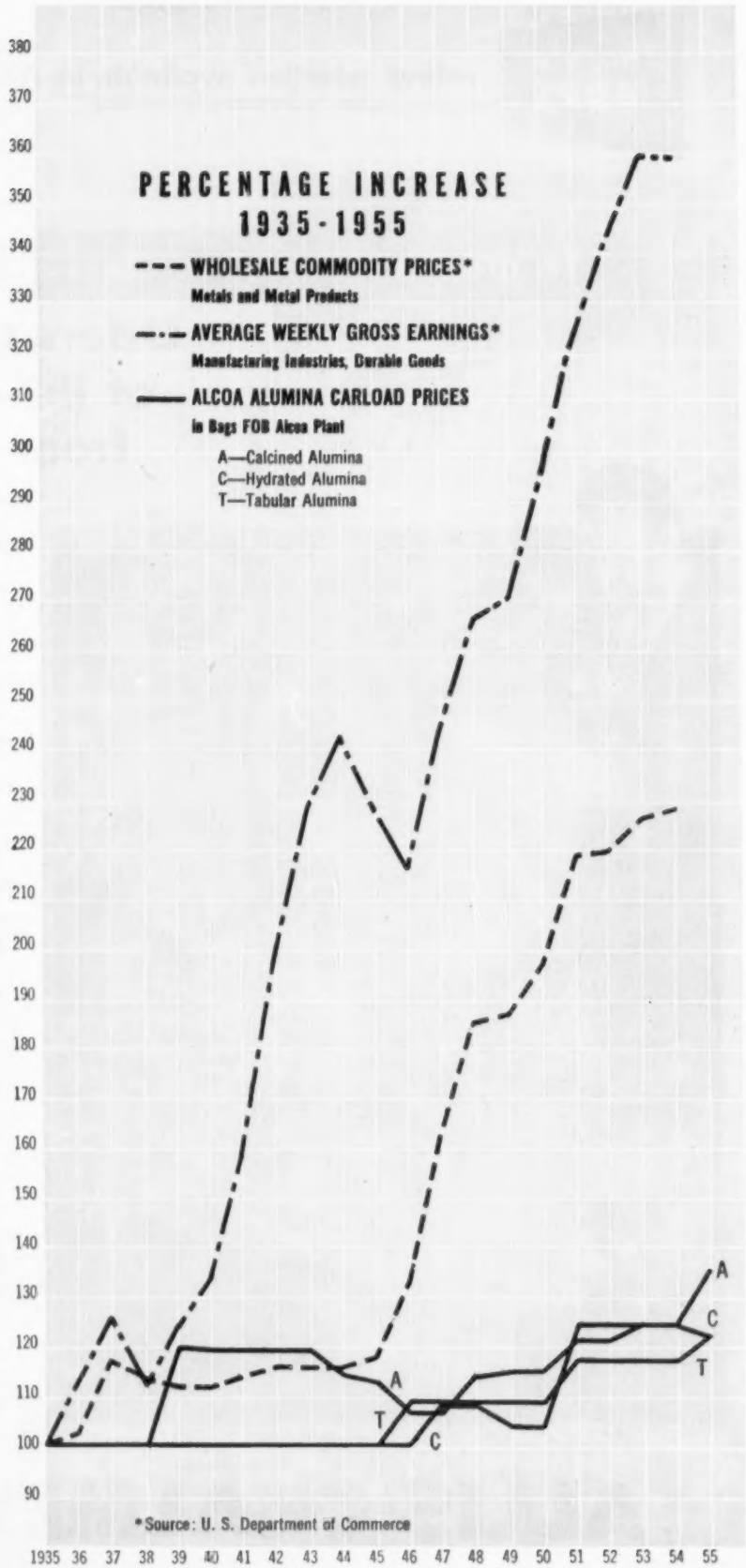
Here is a pricing record almost without parallel in the heavy chemical industry . . . and *you* have helped to make it possible. Constantly increasing tonnages —your orders—plus improved efficiency and equipment, have enabled ALCOA to maintain the price of chemical aluminas at a low and uniform level for more than 20 years.

But many modern industries have discovered that ALCOA Aluminas are very special "best buys," regardless of price. They've found that wherever these versatile aluminum oxides are used, product quality is enhanced, performance is stepped up, processing is more easily controlled.

For example, ALCOA Aluminas make spark-plug porcelains more durable . . . abrasive wheels cut faster . . . refractories last longer, withstand higher temperatures. And ALCOA *Activated* Aluminas do remarkable things as catalysts and catalyst supports . . . dry gases and solids more efficiently than any other commercial desiccants . . . do an outstanding job in maintaining oils. Plastics, rubber, glass, textiles, china, enamel, cosmetics —a seemingly endless list of products— are better when they contain ALCOA Aluminas.

As in the past, ALCOA will maintain its prices at the lowest possible level. So, if ALCOA Alumina is not already one of your best buys, contact us right away. We would like to prove just how *good* a buy can be. Write to ALUMINUM COMPANY OF AMERICA, CHEMICALS DIVISION, 717-A Alcoa Building, Pittsburgh 19, Pennsylvania.

ALCOA CHEMICALS
ALUMINUM COMPANY OF AMERICA






For more data on advertised products, use Readers' Service Cards, last page.

# top Cat on cracking efficiency!

# Aerocat Triple A*

**high alumina catalyst**

## balanced with HI PV*

Both high pore volume and high alumina content—that's what AEROCAT TRIPLE A High Alumina Catalyst offers refiners. This combination boosts cracking efficiency through

**higher initial activity**
**higher thermal and steam stability**
**lower stack losses**
**excellent selectivity**

In AEROCAT TRIPLE A High Alumina Catalyst, Cyanamid has carefully balanced high pore volume with pore diameter and specific surface. The result is higher activity maintenance than is possible with low pore diameter high alumina catalysts.

AEROCAT TRIPLE A is the product of a 7-year research program at Cyanamid. Commercial experience in 24 units has yielded precise determinations of its cracking efficiency and product distribution in equilibrium. It's a proved and tested catalyst!

Your Cyanamid representative will be glad to tell you what AEROCAT TRIPLE A High Alumina Catalyst with HI PV can do for your operation. Call him today.

*Trade-mark

AMERICAN Cyanamid COMPANY
REFINERY CHEMICALS DEPARTMENT
30 Rockefeller Plaza • New York 20, N.Y.
In Canada: North American Cyanamid Limited, Toronto and Montreal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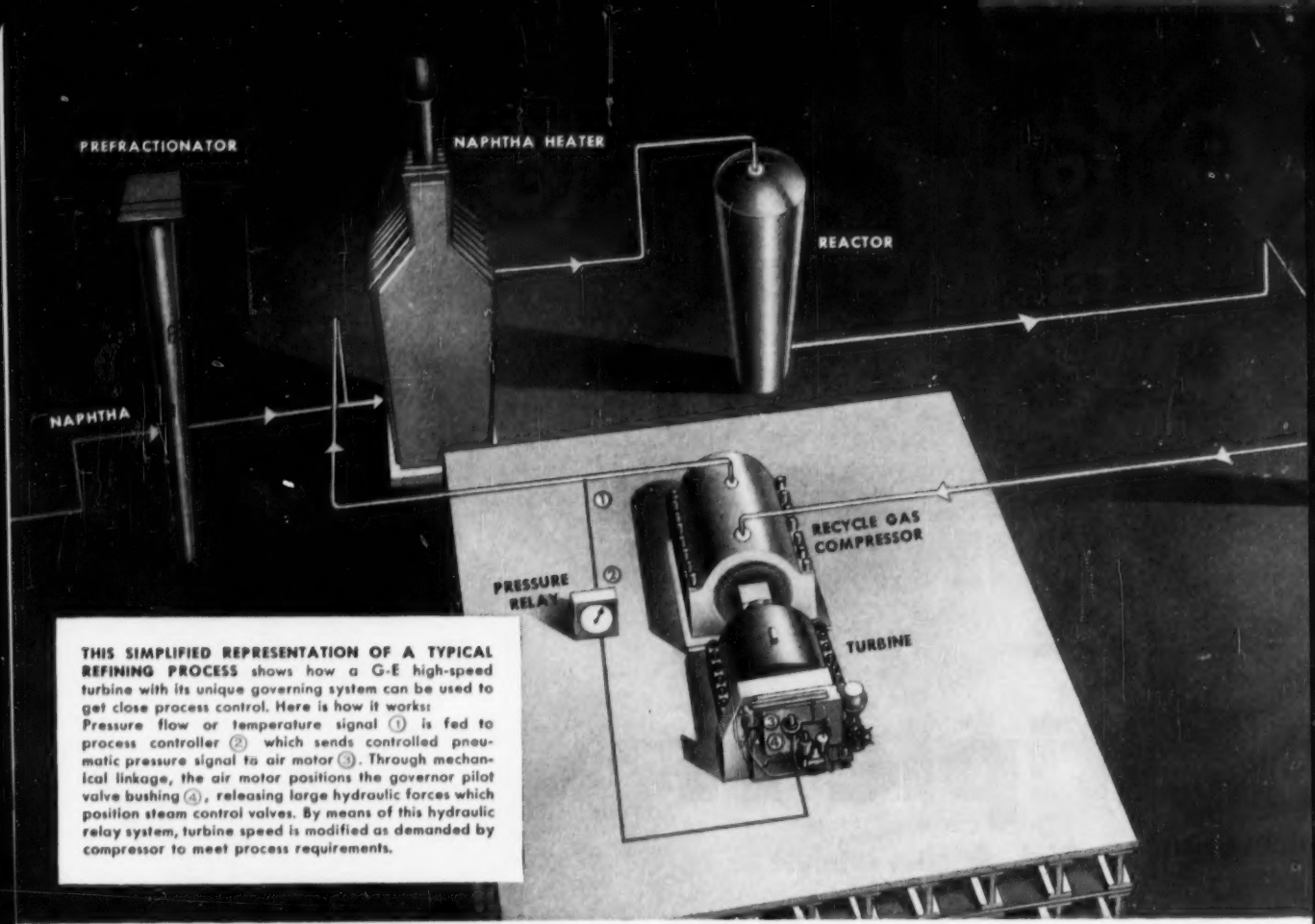
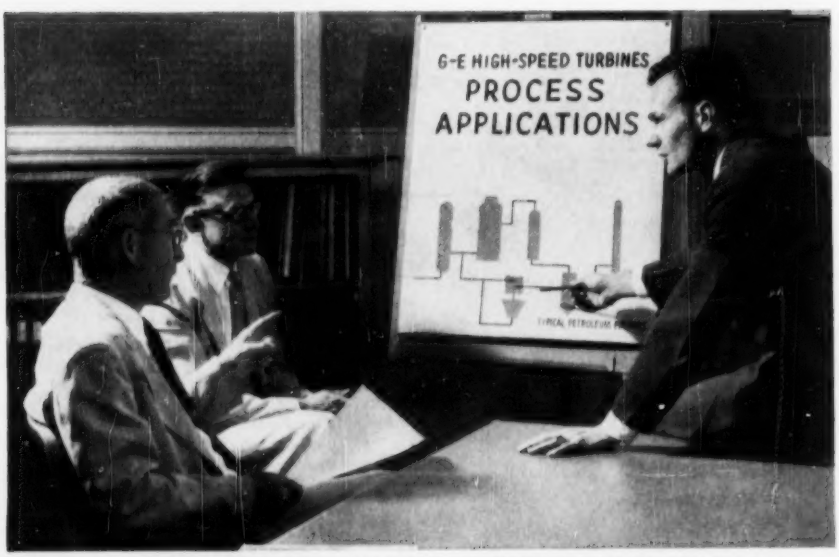



**THIS SIMPLIFIED REPRESENTATION OF A TYPICAL REFINING PROCESS** shows how a G-E high-speed turbine with its unique governing system can be used to get close process control. Here is how it works: Pressure flow or temperature signal ① is fed to process controller ② which sends controlled pneumatic pressure signal to air motor ③. Through mechanical linkage, the air motor positions the governor pilot valve bushing ④, releasing large hydraulic forces which position steam control valves. By means of this hydraulic relay system, turbine speed is modified as demanded by compressor to meet process requirements.

*EASILY INCORPORATED INTO YOUR PRESENT SYSTEM . . .*

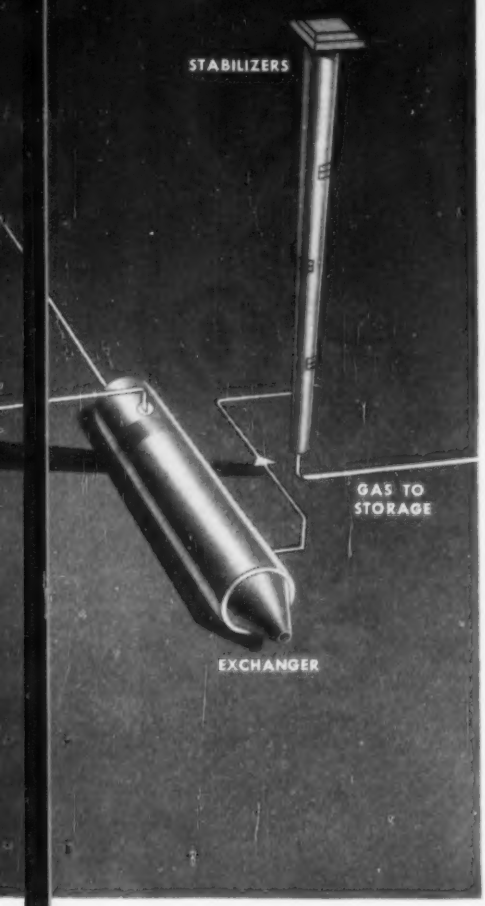
# G-E position-restored turbine governing



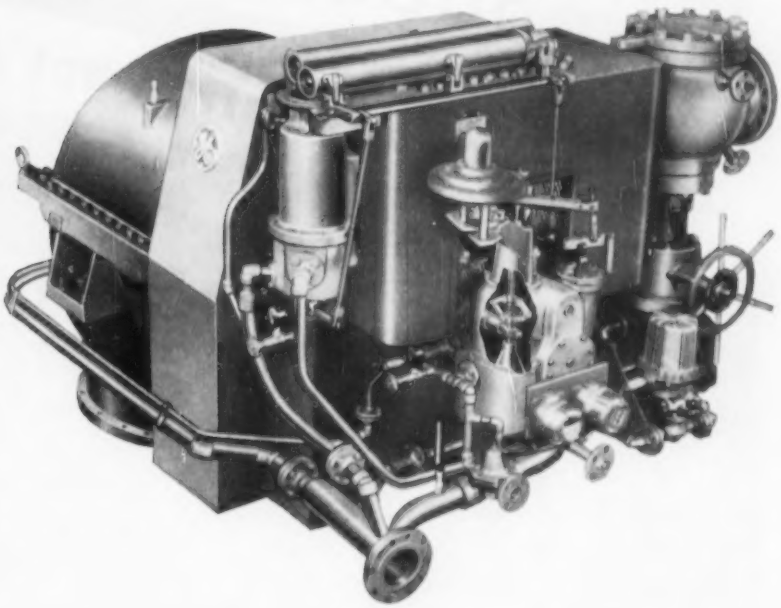

**HERE IS THE SMALL TURBINE AND SUPERCHARGER DEPARTMENT MARKETING TEAM** that can show you how to apply all the advantages of G-E high-speed turbine governing to your process operations. R. E. Donnelly, Manager—Marketing, discusses a possible petroleum application with H. J. Chase, Manager—Engineering, at left, and C. B. Seelig Manager—Sales, center.

**HIGH-SPEED TURBINES FOR ALL PROCESS APPLICATIONS**

- PETROLEUM
- CHEMICAL
- PETROCHEMICAL
- STEEL




## TURBINES FOR HIGH-SPEED COMPRESSORS . . .



**THE GENERAL ELECTRIC POSITION-RESTORED GOVERNOR**, shown cutaway above, utilizes the best features of both mechanical and hydraulic control. Heart of the system is a fly-ball-positioned, rotating pilot valve, which releases a tremendous store of power to position the steam inlet valves. The released power is controlled through feedback by a weight-biased mechanical-linkage that repositions the pilot-valve bushing only in direct response to movement of the steam-inlet valves, rather than in response to a force generated by the movement of the valves.

# can give you close process control

**In process industries,** if quality-control and peak production are to be maintained, turbines that drive high-speed compressors and blowers must have close, accurate governing in response to load requirement and the slightest variations in steam conditions.

To help you get more precise control, all G-E high-speed turbines have a position-restored governor. It is an oil-relayed, mechanical-type control device that automatically matches turbine speed to process demands.

This governor will operate accurately and effectively with any recycle controlling system because the mechanical-linkage can be adjusted to match the complete output-signal range of any process controller. The G-E governor can be incorporated with a typical control system as shown in the schematic drawing.

**FOR CLOSE PROCESS CONTROL** the unique design of the G-E high-speed turbine governor offers these advantages:

**Accurate signal relay** results since speed changes are made through a weight-biased mechanical-linkage which repositions the pilot valve bushing only in direct response to movement of the steam-inlet valve. The system is not affected by oil-flow forces and is quick to respond to changes in process requirements.

**Direct, precise speed settings** are therefore possible because turbine response to process requirements is not dependent on force balance between springs and signal pressure.

**Completely integrated governing** responds not only to process demand but also to steam pressure or temperature changes, which must be factored in for close process control.

**Position-restored governing** keeps the system in near-perfect equilibrium, practically eliminating speed surges and turbine "hunting." Be sure to see how this governing system may be used to advantage in your process operation.

For more detailed information, contact your nearest General Electric Apparatus Sales Office or write General Electric Company, Schenectady 5, N. Y. In Canada, contact Canadian General Electric Company, Limited, Toronto. 241-3

*Progress Is Our Most Important Product*

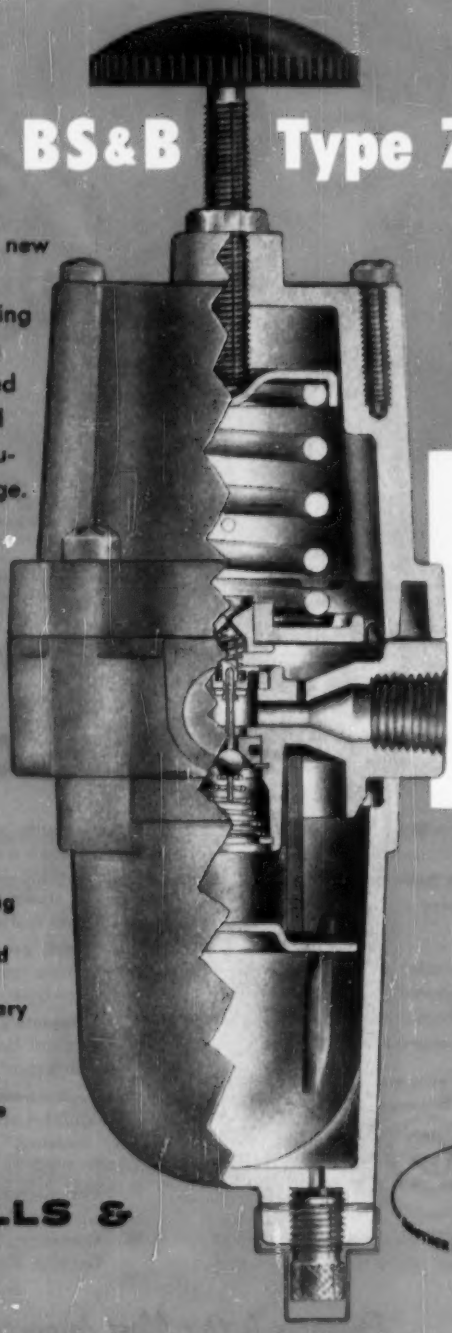
GENERAL ELECTRIC

# INTRODUCING . . .

## Today's Finest Instrument Air Regulator!

## It's The New BS&B Type 73-26!

We invite your comparison of the new BS&B Type 73-26 Instrument Air Regulator with any other make being offered today. When you've seen the differences and have compared performance data, we know you'll agree the 73-26 is the *finest* instrument air regulator in its price range.



**1/4"** Pipe Connections

**40 PSI**—Maximum Reduced Pressure (100 PSI with Special Spring)

**300 PSI**—Maximum Input Pressure

**10 CFM**—Maximum Capacity

### FEATURES

- Higher Air Volumes.
- Improved Corrosion Resistance.
- 40 Micron Phenolic Impregnated Cellulose Filter.
- Minimum Pressure Drift From Set Point.
- Instantaneous Response To Changes In Flow Rate.
- Easy Adjustment To Within Close Limits For Any Pressure Within Its Output Range.
- Can Be Serviced Without Removing From Air Line.
- Can Be Panel Or Bracket Mounted If Desired.
- Available With Or Without Auxiliary Pressure Gauge.

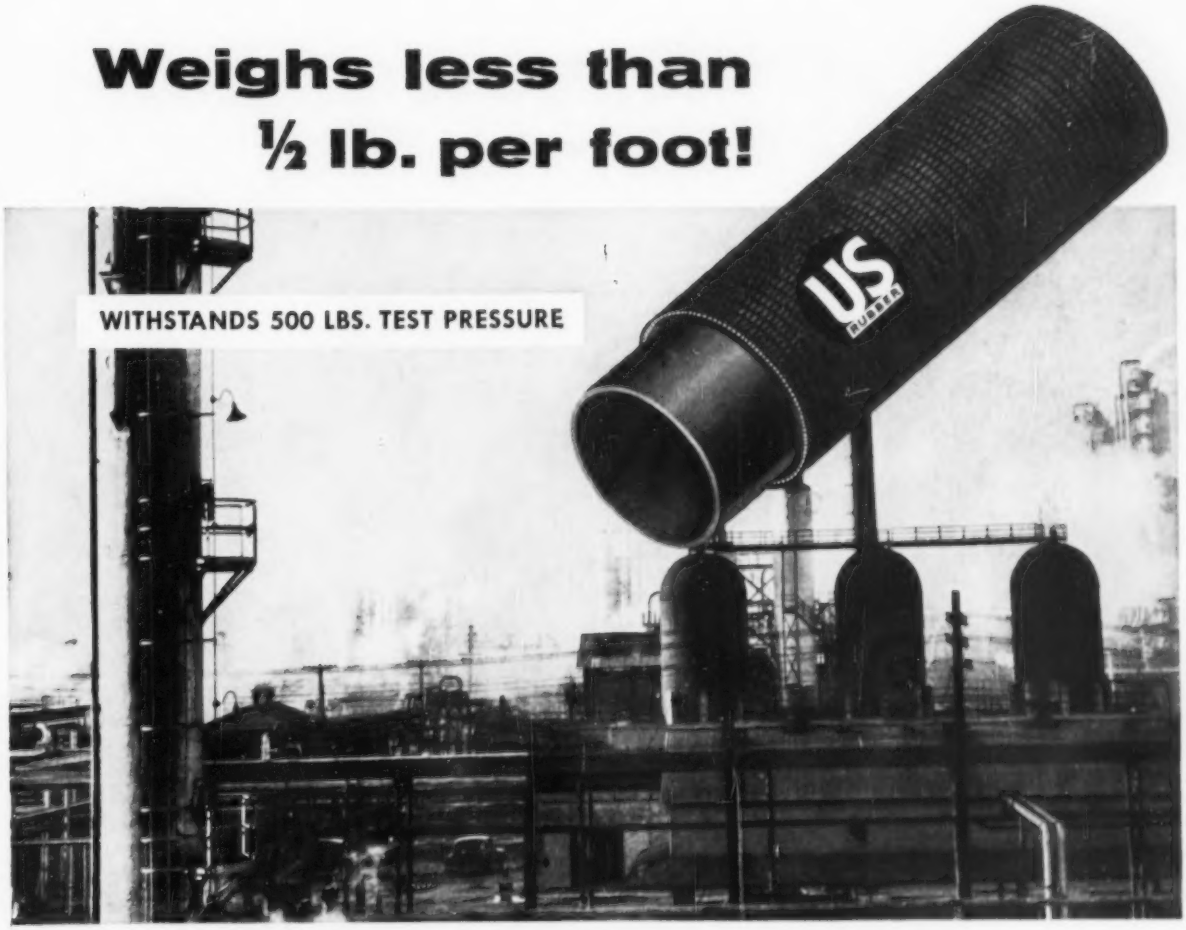
For complete information, contact your BS&B Representative, or communicate directly with . . .

**BLACK, SIVALLS & BRYSON, INC.**

Controls Division, Dept. 4-FI
7500 East 12th Street, Kansas City 26, Missouri

BS&B

# Weighs less than ½ lb. per foot!




## The new super-flexible *All-Dacron*

# U. S. FLEXLITE® FIRE HOSE!

Its single jacket is all Dacron*—to give the lighter weight, pressure resistance, flexibility, rackability required by today's petro-chemical fire departments.

*Although U. S. Flexlite weighs 50% less than conventional hose, it will handle extreme pressures!* Its Neoprene tube and Dacron jacket have the required resistance to chemicals, petroleum, mildew, dampness, heat. Coils easily, dries fast. United States Rubber Company also makes the following hose for the petro-chemical field.

(1) "Reliance®" Double Jacket Dacron reinforced (weighs 50 lbs. per 100 ft.) (withstands 400 lbs. test pressure)

(2) "Reliance" Double Jacket Dacron reinforced (weighs 54 lbs. per 100 ft.) (withstands 600 lbs. test pressure)

(3) U. S. Matchless® Carbolized—most rugged hose in the market.

Get in touch with any of our selected distributors or any of the 27 "U. S." District Sales Offices, or write us at Rockefeller Center, New York 20, New York.

*DuPont's polyester fiber

US RUBBER

**Mechanical Goods Division**

# United States Rubber

*Bridging the gap between research and product sales*

*Throughout the petroleum industry*

## FLUOR BUILDS PROCESSES INTO PROFITS

First comes research and process development . . . both vital to a growing industry. But then someone must translate the process into a full-scale production facility. Here's a recent example of Fluor's outstanding success in linking these two activities.

Using the process developed by Universal Oil Products Company, Fluor constructed for Gulf Oil Corporation the world's largest Platformer, rated at 29,000 barrels/day. The unit converts a naphtha charge into high-octane motor fuel, and the over-all installation includes individual sections for pre-fractionation, fixed-bed catalytic reforming, gas treating and fractionation.

Another "first" in Fluor's growing list of refining accomplishments, the Gulf Platformer is typical of the breadth of Fluor services. Added to responsibility for mechanical design, engineering, construction and process design is an intangible . . . *dependability*, the reason industry has found that you *can* be sure with Fluor.

**FLUOR** ENGINEERS • CONSTRUCTORS

*The FLUOR CORPORATION, Ltd.*

*2500 So. Atlantic Boulevard, Los Angeles 22, Calif.*

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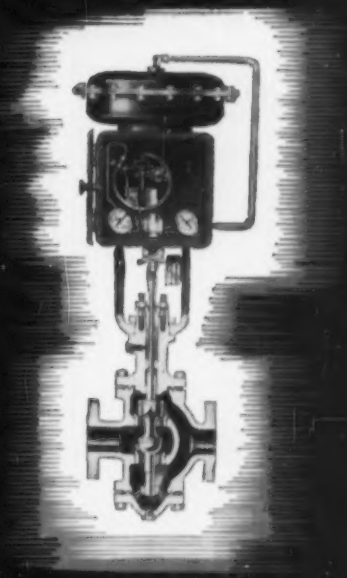
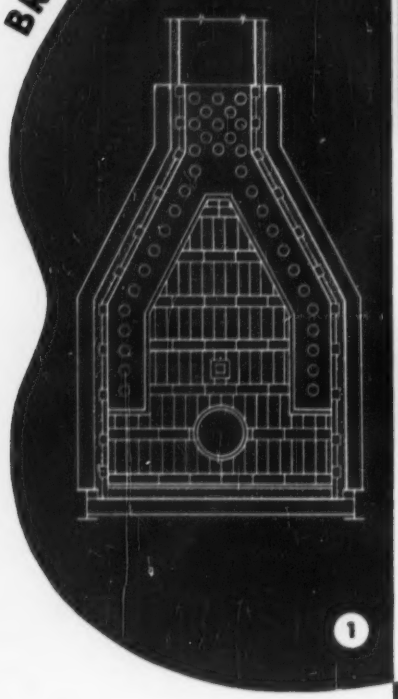


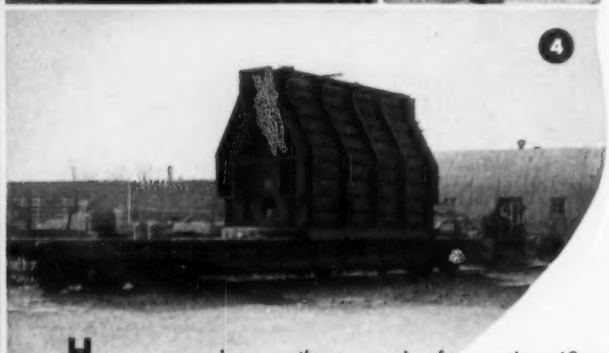
FISHER **WIZARD** - - - *UNIVERSALLY ACCEPTED AS THE WORK HORSE ON PRESSURE CONTROL JOBS*

**FISHER GOVERNOR COMPANY · Marshalltown, Iowa**

WORLD LEADER IN RESEARCH FOR BETTER PRESSURE AND LIQUID LEVEL CONTROL

# BRING YOUR PROBLEMS TO HEAT ENCLOSURE HEADQUARTERS






Here you can draw on the reservoir of more than 40 years of experience in designing and engineering in this specialized field. Here you can put your trust in an organization that has had a life-long policy of making sure that the installation is a success. Here you will find heat enclosure designs engineered to make use of the latest developments of materials and methods.

For example—take note of the adaptability of Detrick construction to this packaged heater.

(1) The drawing shows the composite wall, including thin refractory surface, backed up with ample insulation all securely supported to withstand the shock of transportation.

(2) Installation of the Thermolayer wall was made in the shop under economical working conditions.

(3) This illustration shows how the tile, insulation and a poured layer are held in position on supporting units; stud welded to the casing.

(4) When completed, the whole unit is loaded onto a flat car for transportation to operating location.

Detrick is headquarters for information on heat enclosures. Day by day we are working on problems presented by every phase of industry. May we have an opportunity to work with you.

**M. H. DETRICK COMPANY**
**111 W. Washington Street • Chicago 2, Illinois**

**SEND FOR BOOKLET**

For a complete resume of the development of the art of enclosing heat, be sure to get your copy of **HEAT ENCLOSURE METHODS By DETRICK**, which will be sent on request.

DETRICK Heat ENCLOSURES

# DETRICK
## HEAT ENCLOSURES



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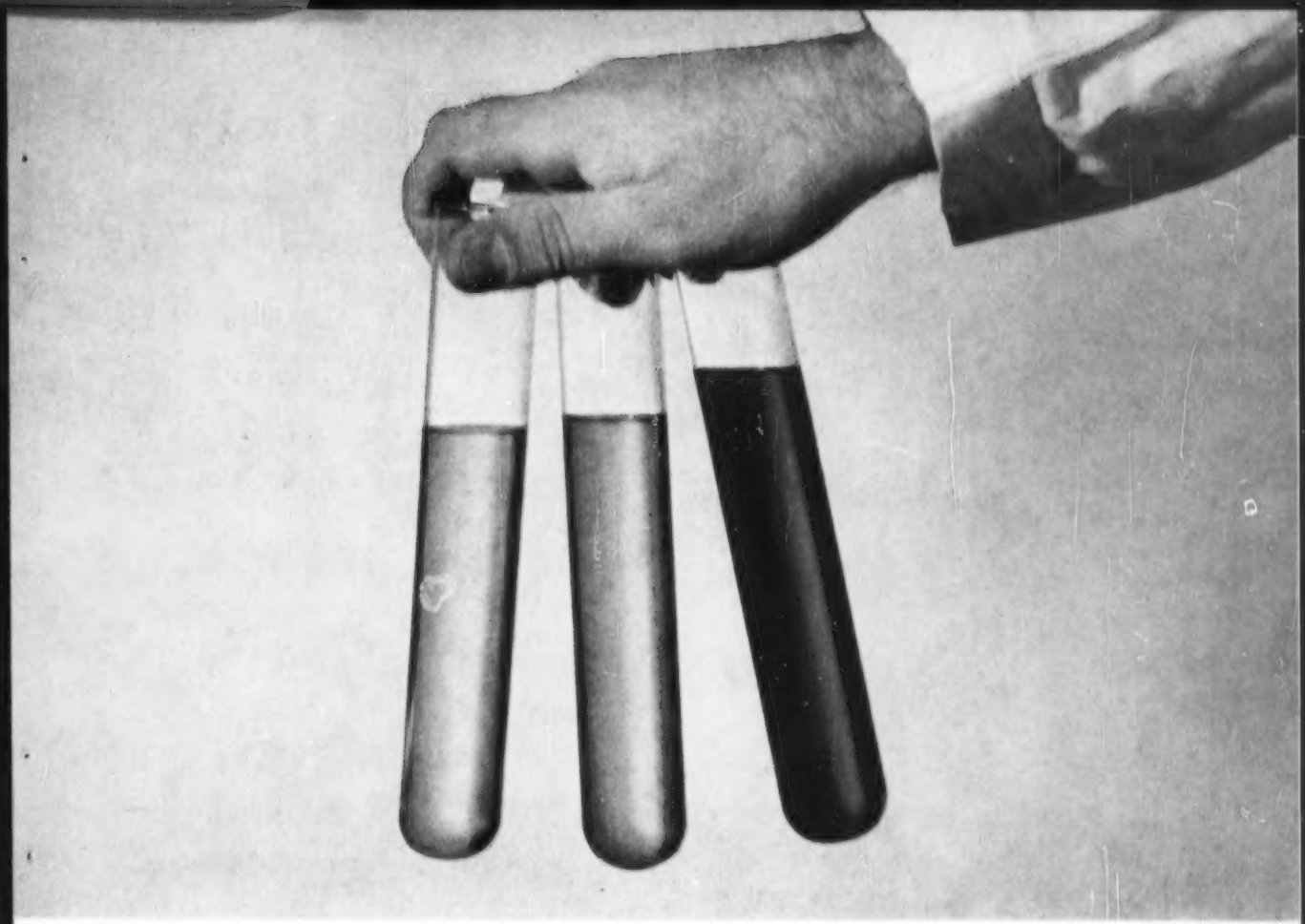

## Shipped 2,000 miles and Stored 4 months...

# NALCO-STABILIZED
# FUEL OIL STAYS CLEAR

This blended straight-run and cat-cracked fuel oil was refined in Texas. Unstabilized, it degraded to N.P.A. Color 4.0 after tanker shipment to New York and subsequent 4 months storage. How the same oil, Nalco stabilized, withstood the trip and storage is dramatically shown in the unretouched color photo, above.

At left, a refinery fresh sample has N.P.A. Color 1.5. Center, Nalco-stabilized sample has N.P.A. Color 2.0 after 4 months. Right, untreated sample has N.P.A. Color 4.0 after 4 months.

Here is real Nalco protection against color degradation . . . protection that has the bonus value of effective sludge prevention. Nalco Fuel Oil Treatment adds up to *better fuel oil salability*, regardless of fuel types, storage or handling problems. Full data are available, now. Call or write for Technical Data Sheets on Nalco stabilizers.

**NATIONAL ALUMINATE CORPORATION**

6216 West 66th Place • Chicago 38, Illinois • POrtsmouth 7-7240

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*The Flox Company, Inc., Minneapolis 3, Minnesota*

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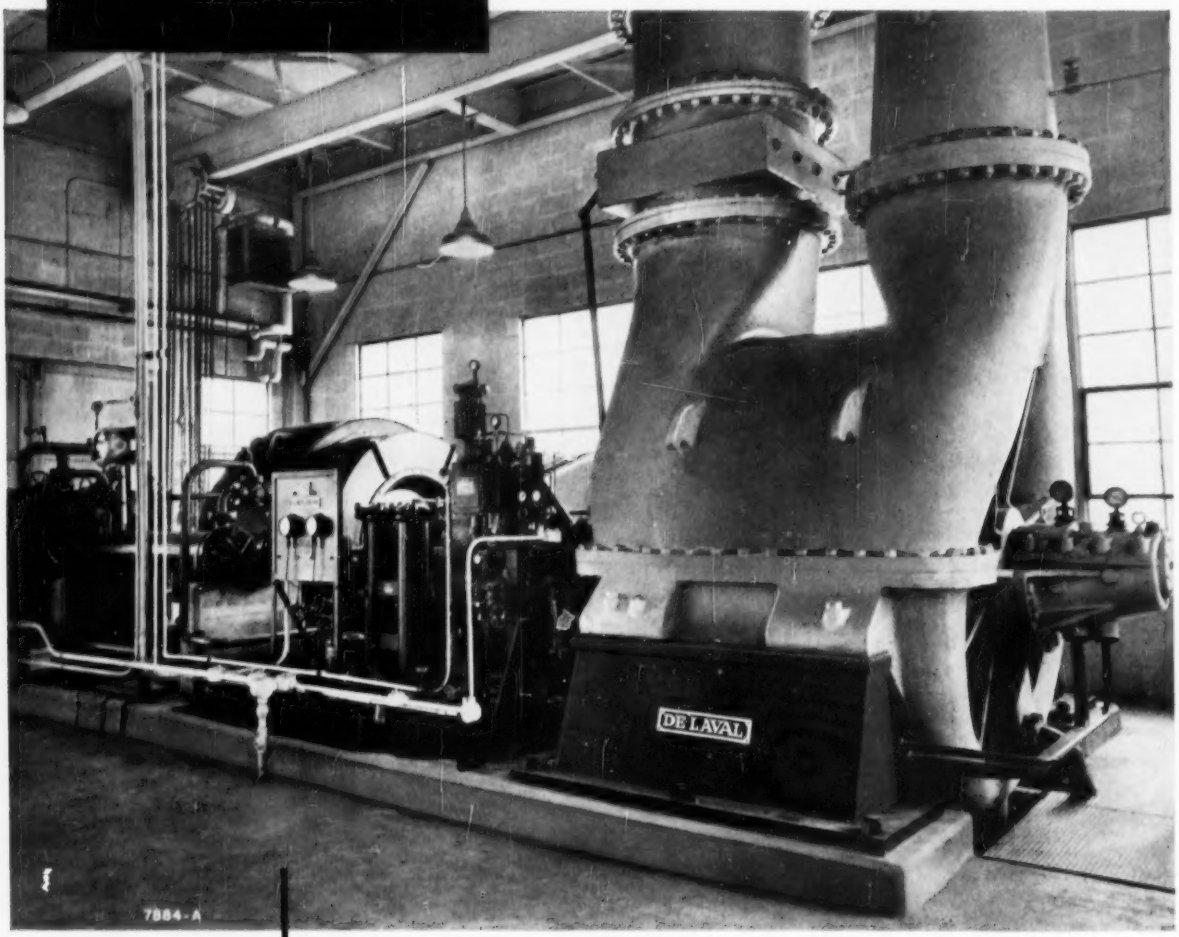
WEST GERMANY: *Deutsche Nalco-Chemie GmbH.*

*nalco*®

**PRODUCTS...** SERVING INDUSTRY THROUGH PRACTICAL APPLIED SCIENCE

# DE LAVAL
## CENTRIFUGAL BLOWER

## *supplies 48,400 cfm for new British American cat cracker*



*Send for new Bulletin 0504*

This De Laval centrifugal blower does a dependable job in the new Model B Orthoflow cat cracker of the British American Oil Co., Ltd. at Clarkson, Ontario.

The unit delivers 48,400 cubic feet of air per minute for the regeneration of spent catalyst. Inlet pressure is 14.2 psia, and discharge pressure 35.4 psia. The De Laval blower operating at 3,700 rpm is driven through a speed increasing gear by a 4,500 hp electric motor.

De Laval blowers are designed and built for heavy duty continuous operation. Rugged, horizontally split casings, individually designed impellers, perfectly balanced rotors and externally mounted, cylindrically seated bearings are design features that assure optimum performance and long service.

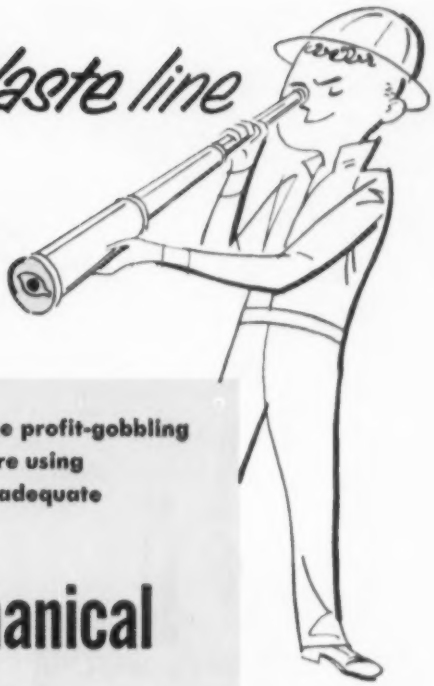
**DE LAVAL** *Centrifugal Blowers*

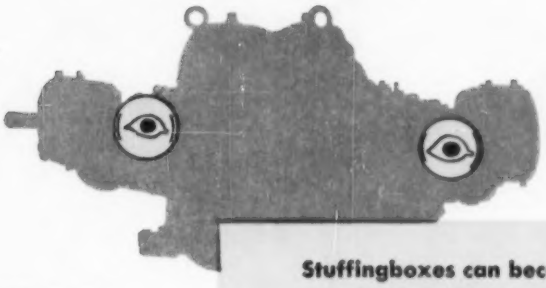
DE LAVAL STEAM TURBINE COMPANY

*811 Nottingham Way, Trenton 2, New Jersey*

DL307

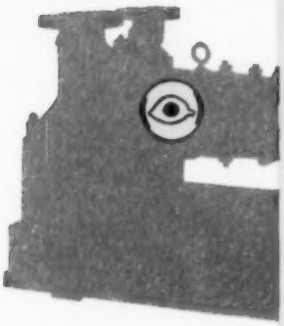
# Watch your pump's Waste line





**Stuffingboxes can become profit-gobbling WASTE LINES if you are using old-fashioned packing or inadequate sealing methods...**

## BJ Mechanical Seals



remove the waste and the worry... eliminate unnecessary leakage... prevent contamination of pumped liquid... protect against volatile liquid hazards... handle high temperatures... do away with repacking expense and repacking downtime losses. Byron Jackson makes a reliable Mechanical Seal for almost every centrifugal pump requirement.

**Byron Jackson**

DIVISION OF BORG-WARNER CORPORATION

P.O. Box 2017, Terminal Annex, Los Angeles 54, Calif.

*You'll do better with...*

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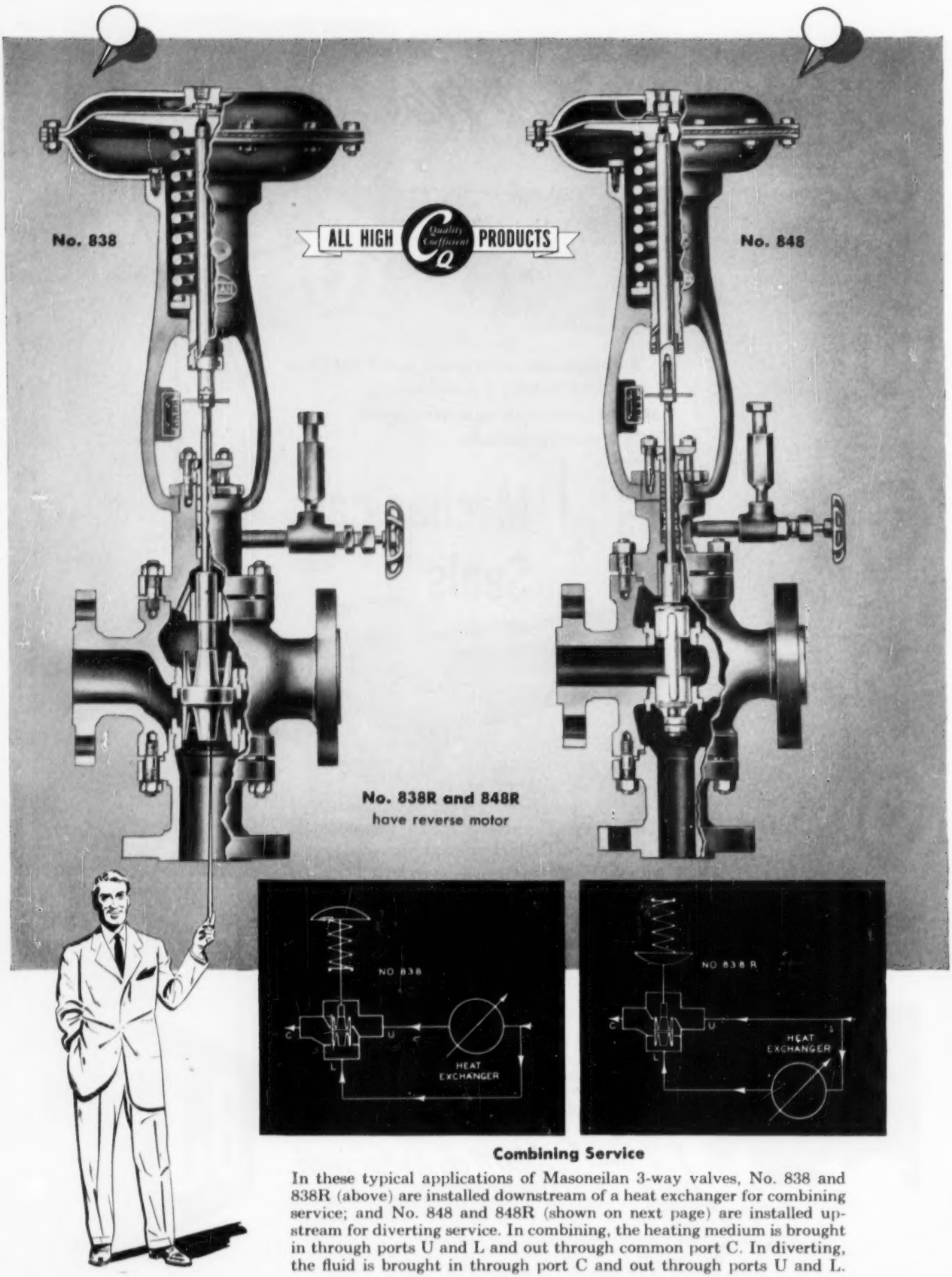



**Combining Service**

In these typical applications of Masoneilan 3-way valves, No. 838 and 838R (above) are installed downstream of a heat exchanger for combining service; and No. 848 and 848R (shown on next page) are installed upstream for diverting service. In combining, the heating medium is brought in through ports U and L and out through common port C. In diverting, the fluid is brought in through port C and out through ports U and L.

***Select Masoneilan 3-Way Control Valves to get...***

# Stability and Flexibility In Combining or Diverting Service

**Choice of seating arrangement** permits installation to obtain the inherent stability (and maximum allowable pressure drop) of flow tending to open both ports. No. 838 and 838R use a single seated body and a plug with seats back to back *inside* the seat rings. No. 848 and 848R use a modified double seated body and a plug with seats face to face *outside* the seat rings. Plugs are *top* and skirt guided for more accurate alignment and long service life.

**Choice of motors** permits obtaining maximum operating force, with same available thrust at both ends of the stroke or with a high thrust in one direction if desirable. 3-15 or 6-30 psi spring ranges and availability of oversize diaphragm cases allow a wide selection of motors, either direct or reverse. Enables you to choose, also, the action providing greatest safety factor in the event of air failure.

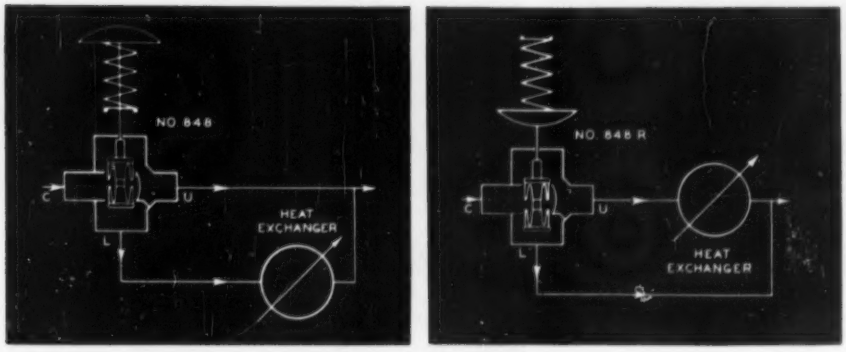
A more detailed discussion of these valves is available. Write our office nearest you, or

**MASON - NEILAN**
**REGULATOR CO.**

MASONEILAN

**1182 ADAMS STREET, BOSTON 24, MASS., U. S. A.**

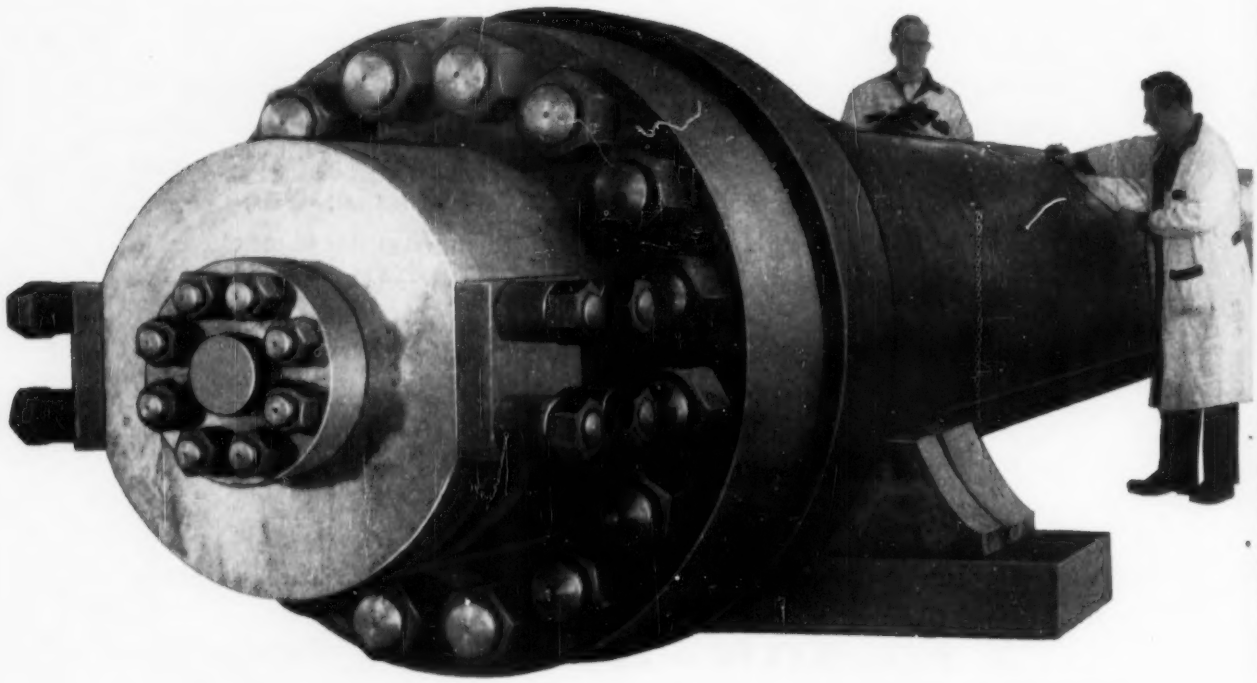
*Sales Offices or Distributors in the Following Cities:* New York • Syracuse • Chicago • St. Louis • Tulsa • Philadelphia Houston • Pittsburgh • Atlanta • Cleveland • Cincinnati • Detroit • San Francisco • Boise • Louisville • Salt Lake City El Paso • Albuquerque • Odessa • Charlotte • Los Angeles • Corpus Christi • Denver • Appleton • Birmingham New Orleans • Dallas • Seattle • Mason-Neilan Regulator Co., Ltd., Montreal and Toronto



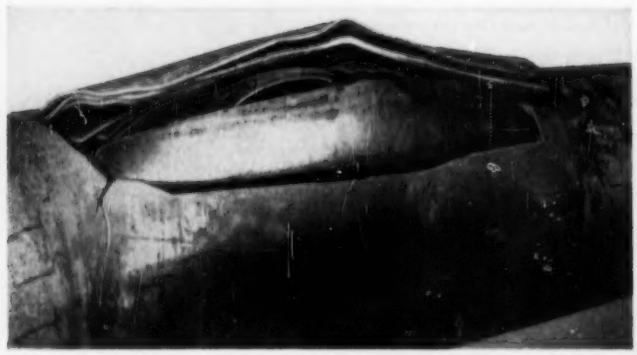

**Diverting Service**

Since maximum unbalance occurs across the bypass port, motor action is normally selected so that an increase in diaphragm pressure will tend to close the bypass port. The flow direction shown in all these diagrams tends to open both ports and maximum motor operating force is available to overcome off-balance. The valves are arranged so that the heating medium to the exchanger will be shut off in the event of air failure.

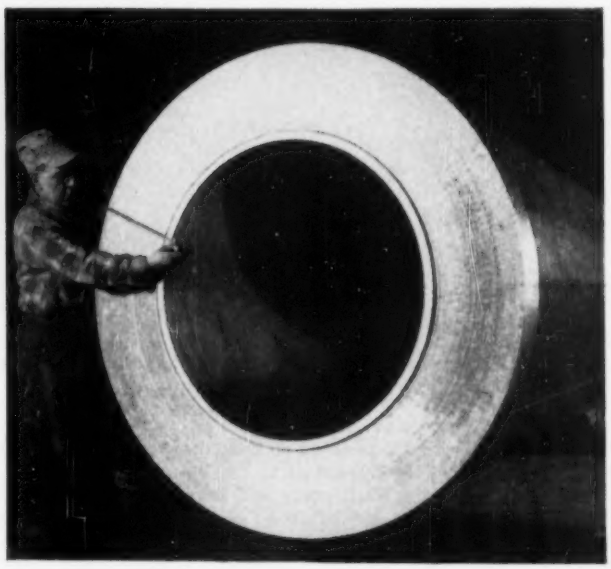
# 8000 pressure vessels ...



**MULTI-LAYER AMMONIA CONVERTER**
**Built for operating pressures of 12,500 psi. . . . test pressures of 18,750 psi.**
**Wall thickness 9 15/16 in. . . . I. D. 25 3/4 in.**
**Overall length is 44 ft. Weight 238,000 lbs.**



**SAFETY** — Nearly 8000 MULTI-LAYER vessels in operation — and not a single failure — certainly convincing proof of the safety inherent in this unique A. O. Smith design. To further prove operating safety, we have actually tested many full-scale, high-pressure MULTI-LAYER vessels to destruction. In every case, vessels rupture without shattering or fragmentation.





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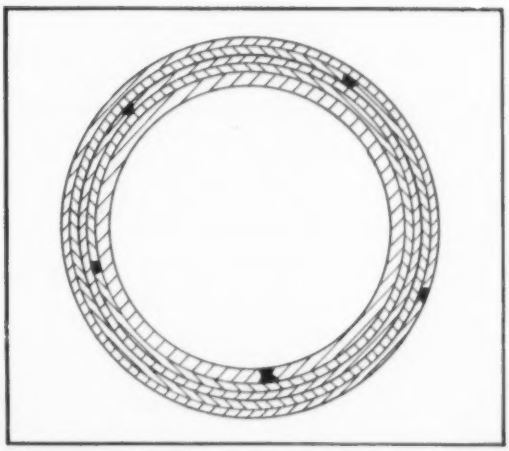
# ...8000 reasons why you can depend on exclusive MULTI-LAYER CONSTRUCTION

## FOR SAFETY

## FOR ECONOMY

## FOR FLEXIBILITY



**ECONOMY** — Savings start with fabrication. Instead of using thick plate in a single wall, MULTI-LAYER vessels are built up from concentric layers of relatively thin steel plate . . . progressively wrapped, tightened and welded together around an inner, pressure-tight cylinder. No need for costly stress-relieving in field assemblies. And for corrosive operations, only the inner shell requires special alloys.

**FLEXIBILITY** —With MULTI-LAYER, there's no limitation of size or weight for your vessel design. You can design for higher pressures, too. Walls can be made stronger simply by increasing the strength of the steel used or by adding more layers. Since shell sections can be welded together in the field, vessel length is not limited.

See how A. O. Smith's exclusive MULTI-LAYER construction can provide safety, economy and flexibility in your own operations. Write our nearest office. We'd be happy to provide more detailed information about MULTI-LAYER construction for high-pressure vessels.

*Through research* ...*a better way*

**A.O.Smith**

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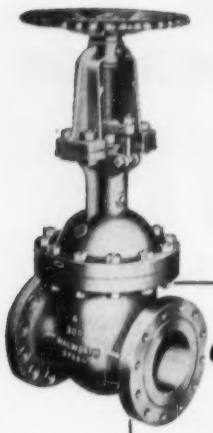
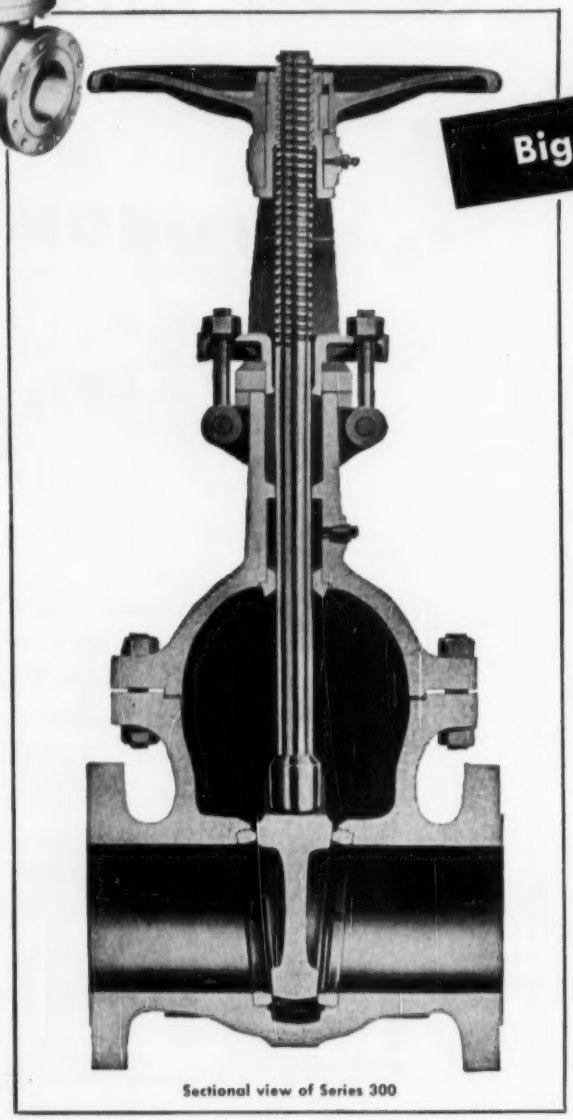
**WALWORTH**

# Cast Steel Gate Valves

***Series 150 and 300***

***Wedge Gate — Outside Screw and Yoke***





Sectional view of Series 300

**Big 8-Point Superiority!**

**Gland** clearances are such that stem cannot be scored if gland should be tightened unevenly.

**Deep Stuffing Boxes** in all sizes (2″ to 24″) insure tightness and maximum packing life — costly leaks are eliminated.

**Bonnets and Bodies** are engineered to withstand pressure and minimize distortion — they're tough, durable, dependable.

**Heavy Steel Walls** provide extra strength and longer life.

**Integral Body Guide Rib Faces** are machined to insure accurate disc seating.

**Seat Rings** are bottom seated — not flange type. No recess exists at back of ring — hence no turbulence, erosion, or pressure drop.

**Streamlined Ports** allow high velocity, non-turbulent flow, and reduce the possibility of erosion.

**Valves** regularly have flanged ends. They can be supplied with ends for butt welding. Roller bearing yokes are available. On valves 5 inches and larger, by-passes can be furnished.

***For Series 600 and higher, we recommend Walworth Pressure-Seal Steel Gate Valves.***

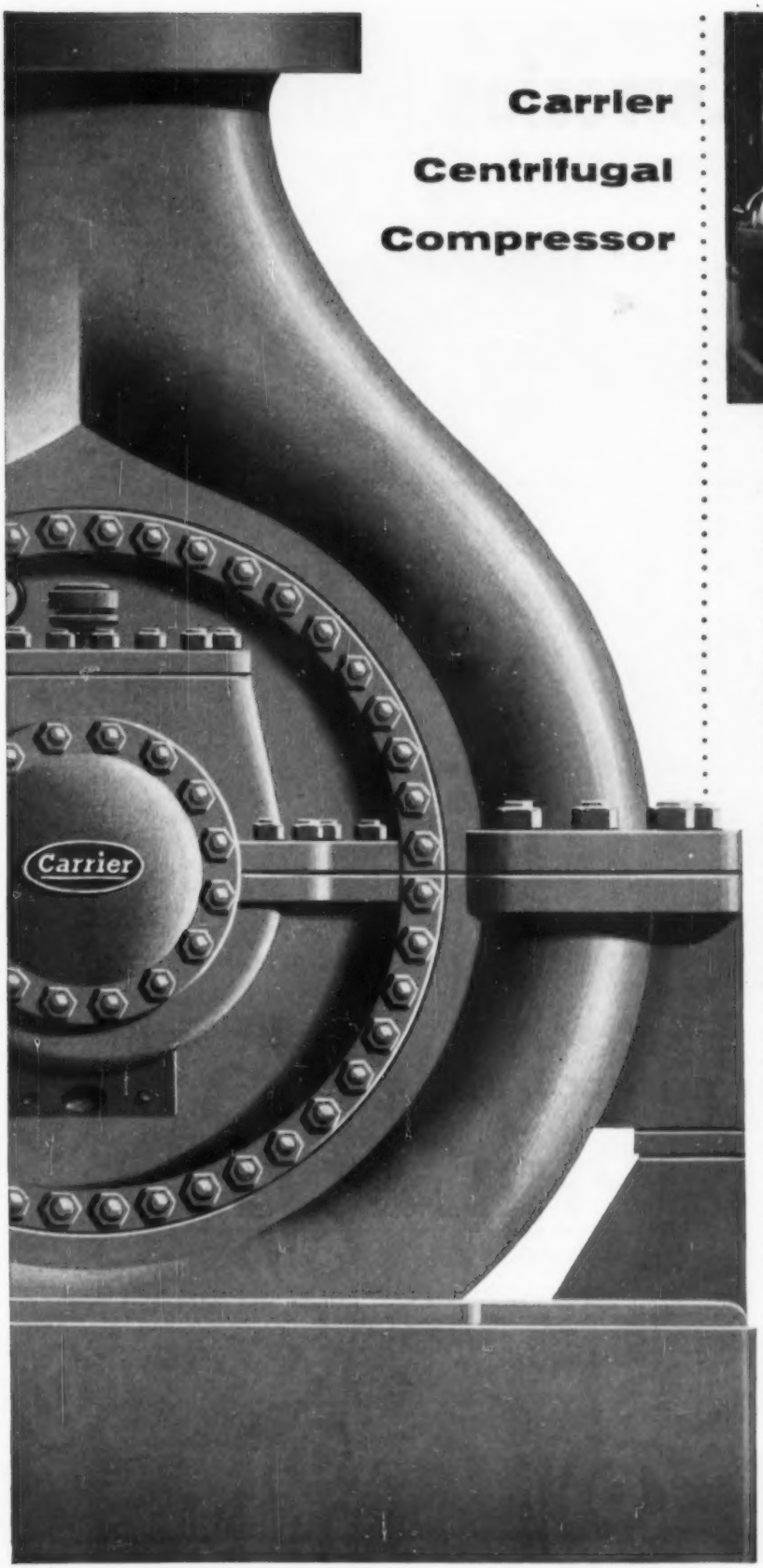
For further information on Walworth Cast Steel Gate Valves, see your local Walworth distributor, or write:

# WALWORTH

## valves and fittings

**60 EAST 42nd STREET, NEW YORK 17, N. Y.**

**DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD**




# Carrier Centrifugal Compressor

on the job at

## The Pure Oil Company

*This Carrier Centrifugal Compressor plays an essential role in the manufacture of high-test motor fuels from heavy oils at the Lemont, Illinois, refinery of The Pure Oil Company. It supplies compressed air to a fluid catalytic cracker to convey and regenerate the chemical catalyst.*

Carrier makes a complete line of centrifugal and axial flow compressors for gas compression and refrigeration—up to 10,000 hp in a single unit. Hundreds of these dependable, efficient Carrier machines are on the job at dozens of refineries across the country—The Atlantic Refining Company, Cities Service Oil Company, Sinclair Oil Corporation, The Texas Company. May we assist *you?*

If you'd like a copy of our booklet **"Centrifugal Compressors for Industry"** please call your nearest Carrier office. Or write direct to Carrier Corporation, Syracuse, New York.

**Carrier**

**centrifugal compressors**
**refrigerating equipment**



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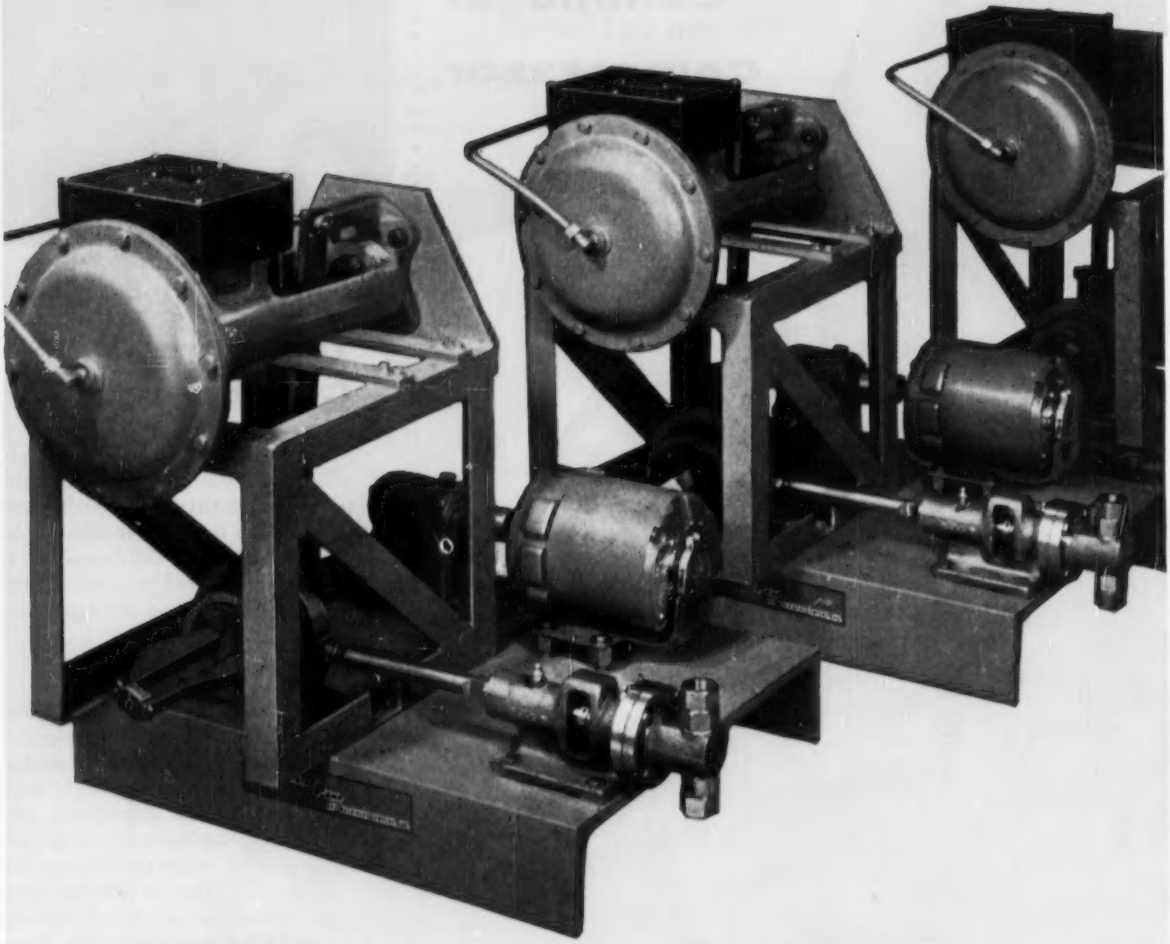
# Pumping Corrosion Inhibitors..



..with metering accuracy of 0.2%

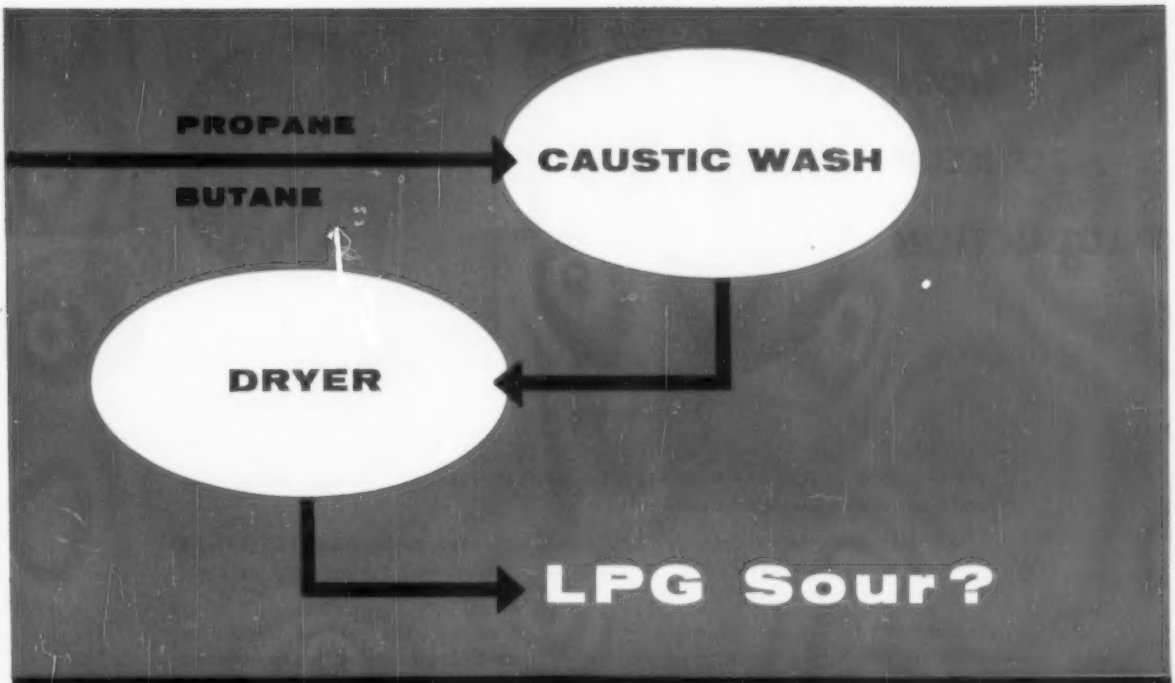
thanks to **PHILATROL***

AUTOMATIC CAPACITY CONTROL

* Illustrated, pneumatically motivated with built-in square root extractor requiring 3 to 15 lb. signal. Also available electrically motivated—50 or 100 ohm slide wire. Hydraulically motivated —50 to 100 p.s.i. hydraulic fluid.

**PHILADELPHIA PUMPS**

PHILADELPHIA PUMP & MACHINERY CO. / 1513 Race St., Phila., Pa. / Subsidiary of American Meter Co.




## Dry it sweet every time with DRIOCEL S®

**DRIOCEL S IS NEW.** It is a low-cost, activated bauxite desiccant specifically developed to overcome souring of LPG products during the final drying step.

**DRIOCEL S PERFORMS A THREE-WAY TASK.**

1. It *does* a thorough job of drying the liquefied products.
2. It *does not* exhibit a souring reaction with sulfur compounds which originate in sour gases and crudes —escape the caustic wash—are entrained in the pre-dryer stream (which may deceptively test "sweet")—and then are decomposed in the dryer by ordinary desiccants to yield sour products.
3. Driocel S *does not* act as an acid polymerization catalyst toward heavy ends of the liquefied gases.

**LONG SERVICE LIFE**—Initial installations put on stream over two years ago are still operating.

**THE SPECIFIC PROPERTIES** of this new drying agent also suggest its use in the drying of chlorinated and fluorinated hydrocarbons.

Under the well-known brand name of Driocel, M & C offers a *complete* line of reliable desiccants for drying air, hydrogen, $CO_2$, hydrocarbon liquids and gases—further proof of our ability to solve many a tough processing problem with versatile sorptive minerals. The coupon will put us to work for you.

ATTAPULGUS **POROCEL PRODUCTS** *from*

**MINERALS & CHEMICALS CORPORATION OF AMERICA**
14 ESSEX TURNPIKE, MENLO PARK, N. J.

ALWAYS A BETTER WAY...

MINERALS & CHEMICALS CORPORATION OF AMERICA
14 Essex Turnpike, Menlo Park, N. J.

Please send me without obligation:

- ☐ Bulletin: "Bauxite As A Drying Agent"
- ☐ Generous sample of Driocel S

name_____ title_____

company_____

address_____

city_____ zone____ state_____



For more data on advertised products, use Readers' Service Cards, last page.

# HOW TO KEEP PRODUCTION UP!

A few generations ago, John Ruskin had a few penetrating remarks to register on business—and what he said makes a lot of sense today.

"The common law of business practice," he commented, "prohibits paying a little and getting a lot. If you deal with the lowest bidder, it's well to add something for the risk you run. And if you do that, you will have enough left over for something better."

Let's translate this in terms of furnace construction for refineries. If you buy a heat enclosure for a job where high and continuous production is a must, then it's imperative that you invest in one that will stand the gaff. To make sure, you've got to build a unit which is properly engineered for the job it must do. You pay more, of course. But it's poor economy—and often embarrassing—to plow money back into repairs right at the peak of production.

That's all we have to say. You get sound engineering and a job designed to stay on stream when you come to Bigelow-Liptak. We've been designing refinery furnaces for years—erecting them, too. Both suspended and castable construction—the one that's best for the job—are used. Better investigate—right now!

FIRST COST OF AN INFERIOR JOB

PLUS REPAIRS AND LOST PRODUCTION

FIRST COST OF A BIGELOW-LIPTAK JOB

**BIGELOW-LIPTAK** *Corporation*

AND BIGELOW-LIPTAK EXPORT CORPORATION

2550 WEST GRAND BOULEVARD, DETROIT 8, MICHIGAN

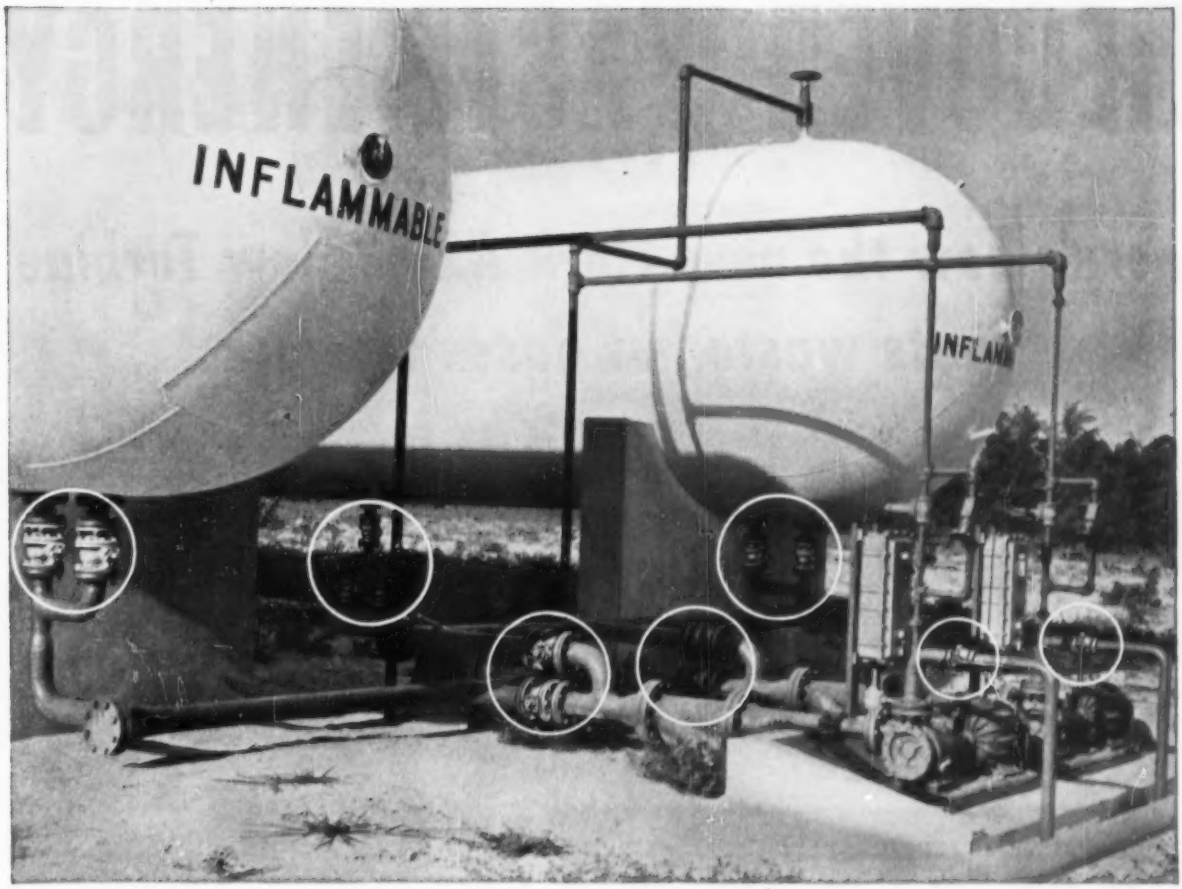
**UNIT-SUSPENDED WALLS AND ARCHES**

*In Canada:* BIGELOW-LIPTAK OF CANADA, LTD., *Toronto, Ontario*

ATLANTA • BOSTON • BUFFALO • CHICAGO • CLEVELAND • DENVER • HOUSTON • KANSAS CITY, MO. • LOS ANGELES • MINNEAPOLIS • NEW YORK
PHILADELPHIA • PITTSBURGH • PORTLAND, ORE. • ST LOUIS • ST PAUL • SALT LAKE CITY • SAN FRANCISCO • SEATTLE • TULSA • VANCOUVER, B. C.



For more data on advertised products, use Readers' Service Cards, last page.




# *The valve that "plays ball" with LP men*

The valves are important wherever there are oil lines.

Here at Hiwan Oil Company, Houston, Texas, there are Rockwood Ball Valves at a dozen points in the lines. Here there's perfect safety, because the Rockwood seal is leakproof . . . speed of transfer, because of Rockwood's full round flow . . . quick operation because a quarter turn does the trick.

Yes, here are the four exclusive features that explain and guarantee the performance of Rockwood Ball Valves —

**Full Round Flow** — no change in shape or volume of fluid stream — no turbulence — no minimum loss.

**Quick Opening and Closing** — only a quarter turn needed.

**Longer Wear-Resistance** — Chrome-plated bronze ball withstands abrasion, pitting and scratching.

**Leakproof Seal** — pressure of fluid automatically positions ball against seat to form tight seal.

## ROCKWOOD BALL VALVES

If you are not now using Rockwood Ball Valves, send coupon today for complete information. Valves come in all pipe sizes. Tested and listed by Underwriters' Laboratories, Inc. Distributors in principal industrial areas.

ROCKWOOD

**ROCKWOOD SPRINKLER COMPANY**
**788 Harlow Street**
**Worcester 5, Mass.**

Send me illustrated folder V-4 on Rockwood Full-Flow Ball Valves.

*Name* .....
*Title* .....
*Company* .....
*City* .....
*Zone* ..... *State* .....



For more data on advertised products, use Readers' Service Cards, last page.

# RECOVER WASTE ENERGY

## *here's how the new Clark Axial Flow Turbine puts waste hot gases to work*

By expanding high temperature gases through the new Clark Axial Flow Turbines, up to 6500 hp can be recovered. Their conservative speeds permit direct connection, without gearing, to centrifugal compressors.

Built in two models, covering a 1500-6500 hp range, with inlet capacities of 3500-10,000 cfm, these highly efficient, specially designed, ultra simple Clark units can operate on gases with temperatures in excess of 1000 deg. F. They are ideally suited to use as recovery turbines in nitric acid plants, refrigeration cycles and, in fact, any place or process where there is a substantial volume of clean gases at moderate pressure and high temperature. Already, there are several in operation with more being built.

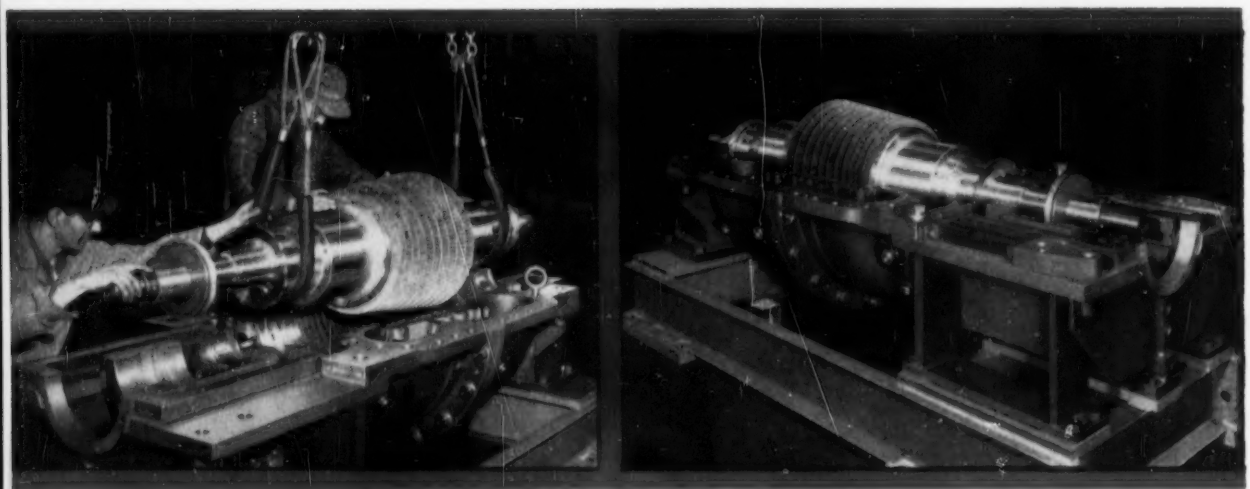
No longer need you confine your thinking to process temperatures under 1000 deg. F., because of a lack of suitable high temperature equipment. No longer need you throw away valuable heat energy. The new Clark Axial Flow Turbine may well solve your problems. Consult the nearest Clark office.

**CLARK BROS. CO. • OLEAN, N. Y.**

Offices in Principal Cities throughout the World

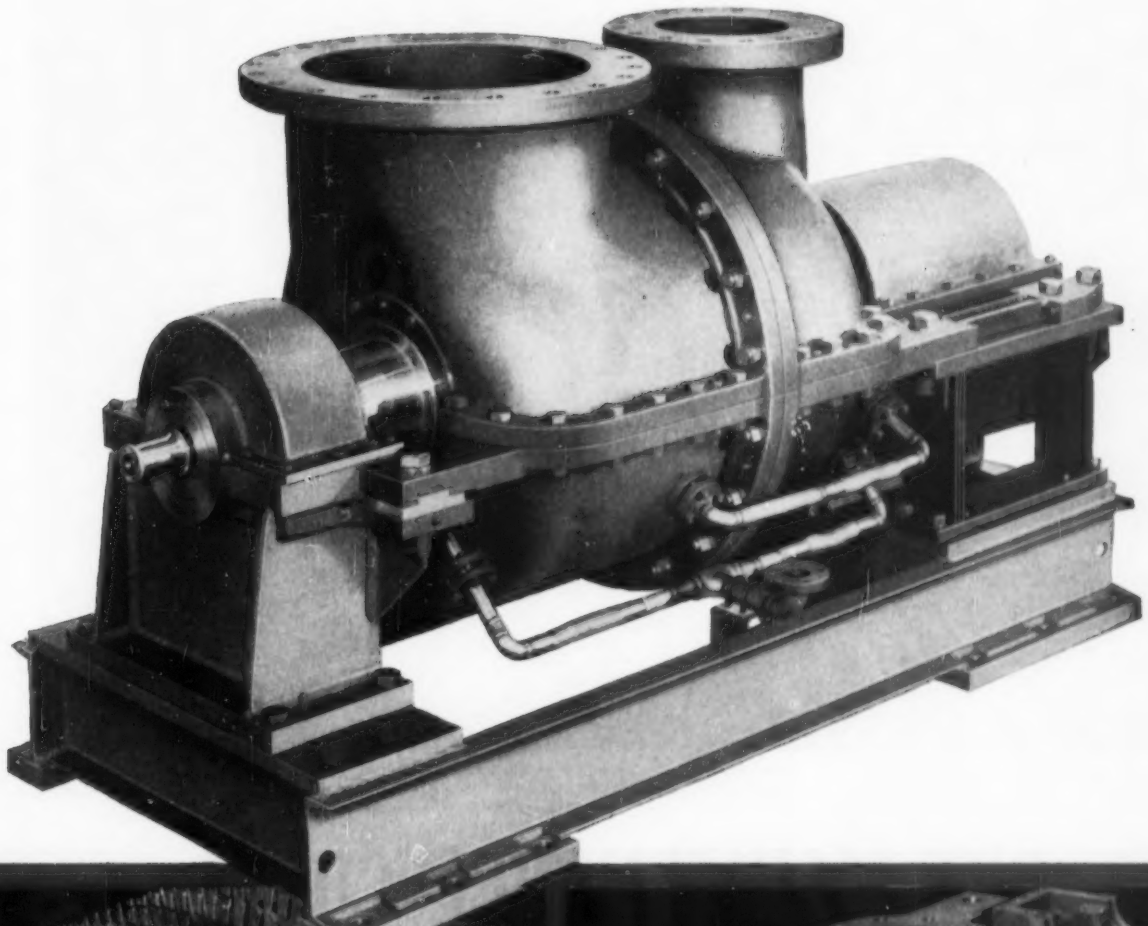
**CLARK** — ONE OF THE DRESSER INDUSTRIES

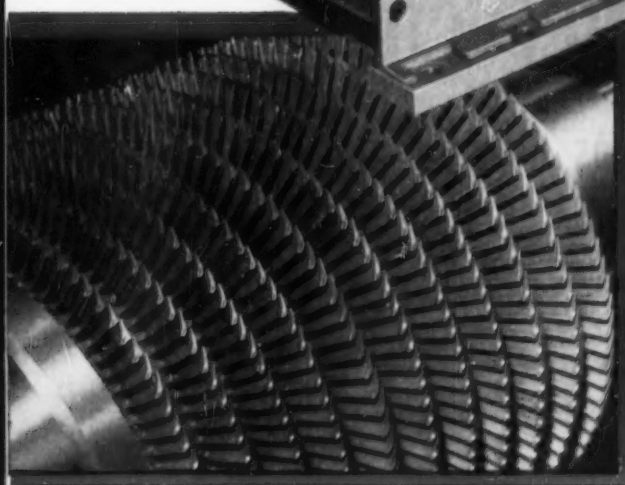
**TURBINES**
**ENGINES**
**COMPRESSORS**

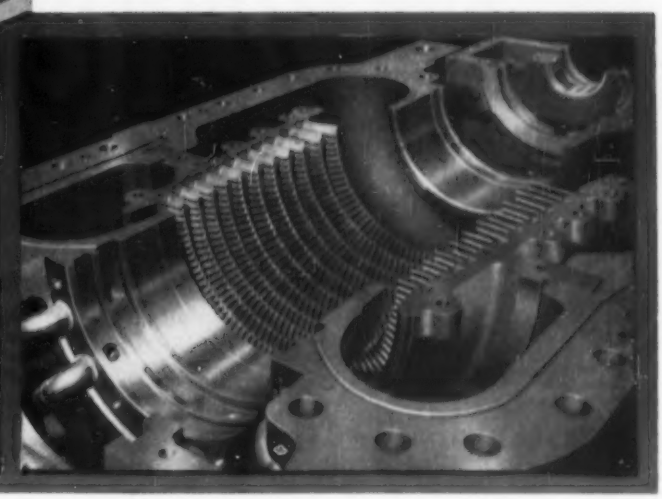


- Rotor dynamically balanced for vibration-free operation.
- Simple, accessible design for easy maintenance.
- Generous diameter, stiff shaft, rotor design.
- Unique Clark thermo-elastic support.
- Free radial and axial expansion without misalignment and distortion.
- Packaged. Mounted on a fabricated base and shipped as a complete drive assembly. Up or down connections.

# why let valuable hot gases go up the stack?



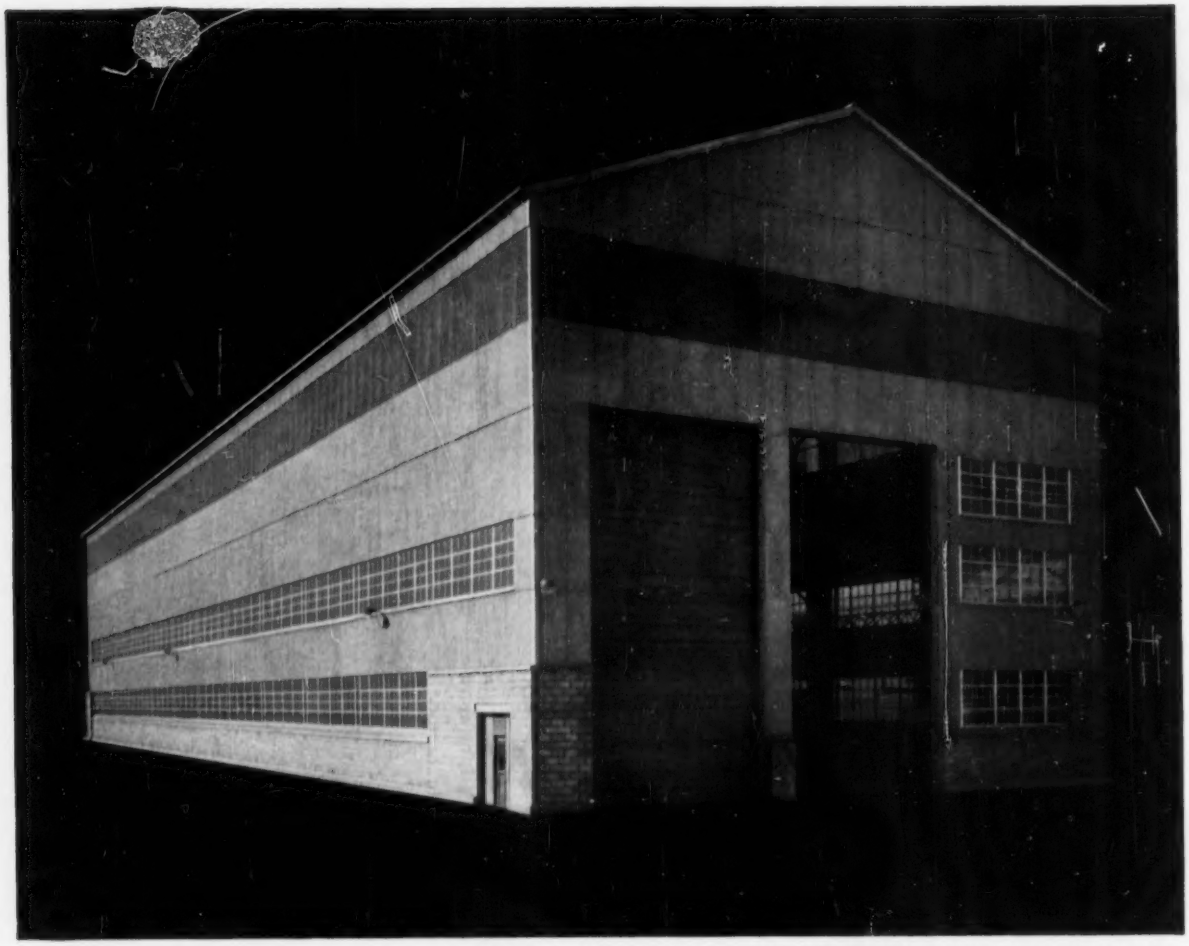




- Multi stages for minimum leaving losses.
- Twisted blades for maximum blade efficiency.
- Feather tip blades for close clearance — minimum inter stage losses.
- Bearings completely isolated from case.
- Stator blade carrier ring free to expand on guide pins in tongue and groove joint.



For more data on advertised products, use Readers' Service Cards, last page.



**Years of service.** Long, trouble-free life is assured by K&M Corrugated Asbestos Sheets. They are used on the roof and sides of this building at the Osgood Company, Marion, Ohio. Application Contractor: Elwin G. Smith Co., Toledo, Ohio.

# CUT MAINTENANCE COSTS

## with K&M Corrugated Asbestos Roofing and Siding

When K&M Corrugated Asbestos Sheets go up, upkeep expenses stay down. They never need protective painting, require little or no maintenance.

**Really rugged.** These sheets are strong, dense, and tough. Made of asbestos fiber and portland cement, they won't burn, rot, or corrode. And they're highly resistant to extremes in weather.

**Big savings.** These corrugated sheets make possible low application costs—they need only a minimum of cutting or fitting. And they offer the extra money-saving feature of needing little or no upkeep.

**Send for details.** At your request, we'll gladly send complete data on K&M Corrugated Asbestos-Cement Sheets. Write today.

**KEASBEY & MATTISON**
COMPANY • AMBLER • PENNSYLVANIA

K&M best in asbestos®



For more data on advertised products, use Readers' Service Cards, last page.

# Corrosioneering News

Quick facts about the services and equipment Pfaudler offers to help you reduce corrosion and processing cost.

*Published by The Pfaudler Co., Rochester, N.Y.*


# What Progress Against Corrosion in 1955?

*A top-level report by* DONALD A. GAUDION

*Vice-President,* The Pfaudler Co.

How big a problem is corrosion?

Some sources tell me it costs industry about six billion dollars a year. In petroleum alone, every barrel of crude oil processed eats up 9¢ worth of equipment.

And with today's trends toward higher pressures, higher temperatures, continuous processes, you can expect corrosion to step up its attack on your equipment.

At Pfaudler, we traffic in corrosion-resistant equipment. Our specialty is a material called "glassed steel"—acid-alkali-resistant glass, permanently fused to steel, to give you the corrosion resistance of glass plus the structural strength of steel.

At the same time we have developed a broad knowledge of corrosion-resistant alloys, like Hastelloy, inconel, monel; the stainless steels; aluminum; copper; titanium; and synthetics, such as Teflon and Kel-F.

**Guarantee against corrosion**

Several innovations appeared, to help you lick corrosion. A hitherto unheard of guarantee was given: No corrosive destruction for 12 months on Pfaudler glassed steel equipment!

We also introduced a new glassed steel dryer-blender . . . Bigger reactors in money-saving *standard* designs . . . New nonmetallic seals for agitators on reaction kettles . . . New glass Turbogrid column trays . . . and other new or improved units.

While our research crew probed the future, we also added greatly to our knowledge of corrosioneering by examining reports from users of Pfaudler equipment over the past year. For example, we learned that, in 28 installations, our "packaged" system for plating acid recovery usually paid for itself in 6 to 12 months.

**More engineering services**

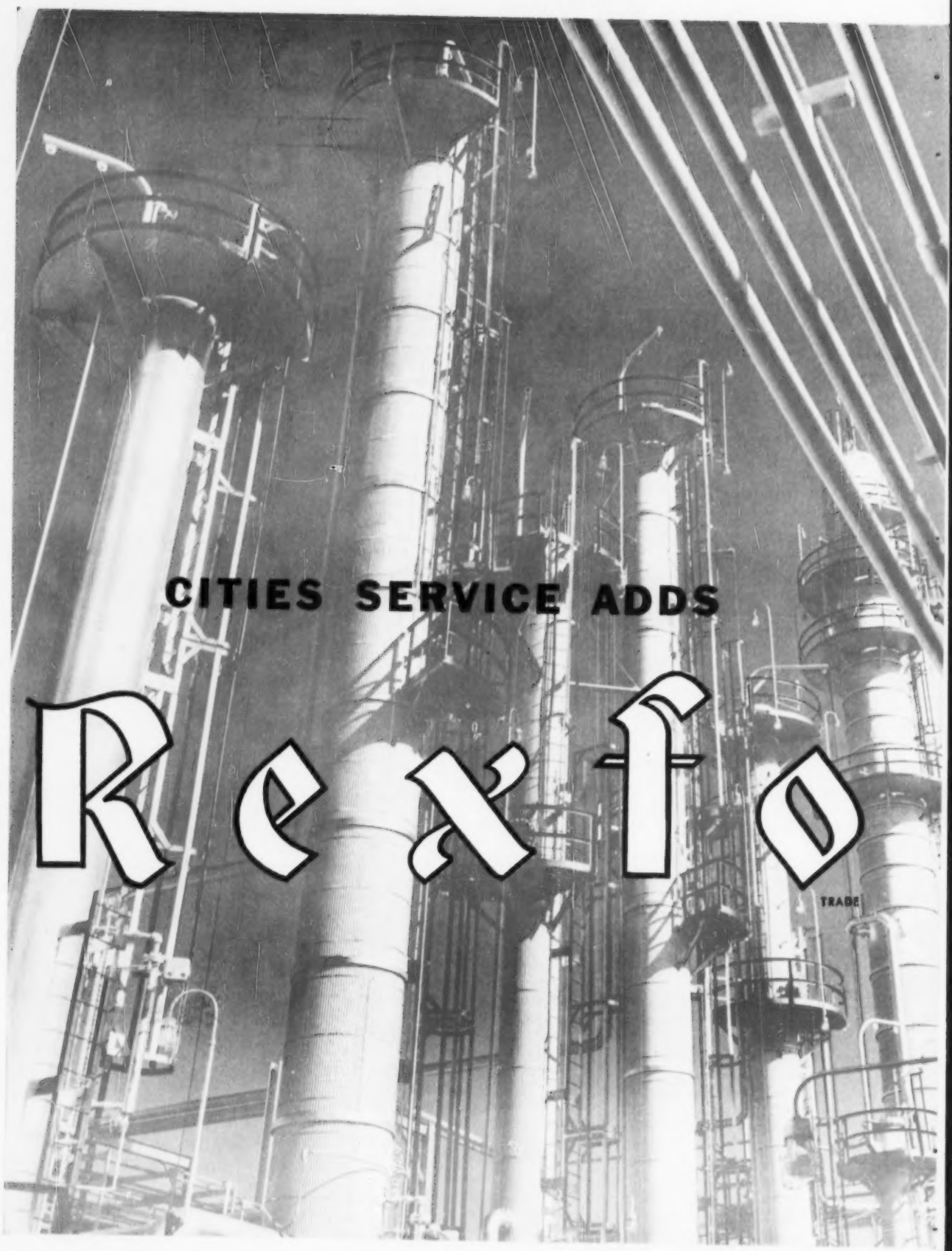
To further help you with corrosion problems, we revamped our technical staff, adding a new Applications Engineering Group. You can add their experience to yours whenever you are faced with special projects. They can "take over" if you want them to.

**Corrosion Seminars**

To increase general knowledge of new developments, we conducted four Corrosion Seminars during the year. Also, technical talks and articles were delivered by Pfaudler people. In research, we have continued our scholarships at Ohio State, Rochester, and Penn State Universities, Rochester Institute of Technology and Rensselaer Polytechnic Institute.

To you, who must pay the bill for corrosion, we believe these progressive steps are significant and worthy of your investigation. Meantime, we are searching daily for new approaches, and will report frequently to you on the pages of this publication.

*A comprehensive report on the new equipment mentioned by Mr. Gaudion is available, and will be sent to you on request.*



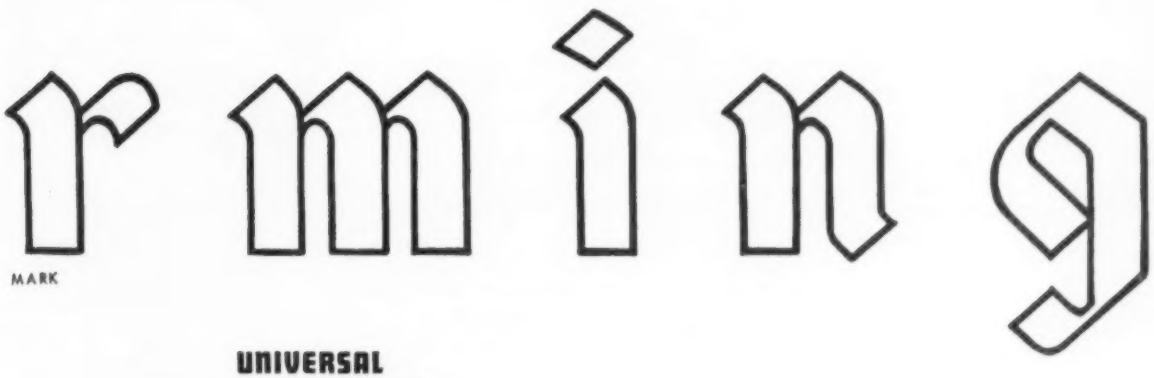



For more data on advertised products, use Readers' Service Cards, last page.

After an exhaustive study, Cities Service Oil Company (Del.) has chosen the UOP Rexforming process as the best method for upgrading low octane naphthas to meet the rapidly increasing demand for higher octane gasolines.

A 6,000 barrel per stream day Rexformer will be installed at Cities Service Ponca City, Okla., refinery as an important part of an extensive new construction and expansion program.

By installing the Rexforming process, the latest development in the catalytic reforming field, Cities Service will be assured of obtaining the best yields of the highest octane blending material for the company's motor fuels. Rexforming, developed by Universal, is capable of producing gasolines having octane ratings considerably in excess of 100 clear.



MARK

**UNIVERSAL OIL PRODUCTS COMPANY**

30 ALGONQUIN ROAD,
DES PLAINES, ILL., U.S.A.

*Forty Years Of Leadership*
*In Petroleum Refining Technology*



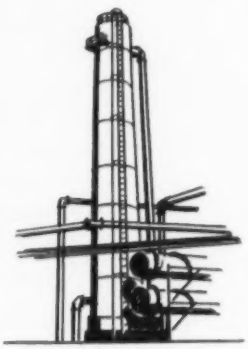
For more data on advertised products, use Readers' Service Cards, last page.

# OAKITE *Maintenance* CLEANING

## helps maintenance crews save time, cut costs, keep equipment operating efficiently

Specialized Oakite cleaning, descaling and related materials plus Oakite up-to-date methods are widely used in all branches of the petroleum processing industries. These specialized materials and methods . . . developed through more than 45 years of experience . . . are designed to provide you with the best in all round cleaning efficiency. What is more—all Oakite materials are backed by a binding guarantee. Your interests are fully protected.

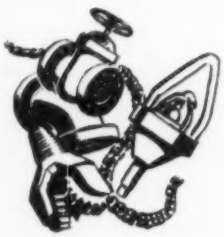
Here are four maintenance jobs, typical of the type of many, Oakite is called upon to do every day of the year. These cleaning operations are fully covered in our free booklet "What Petroleum Men Should Know to Simplify Cleaning". Send for a copy.



1 **TOWER CLEANING.** Oakite lists a wide variety of compounds for removing waxes, resinous products, iron sulfides, oxides and other deposits from bubble caps, trays, downcomers. Circulation method eliminates costly manual cleaning.

2 **HEAT EXCHANGERS.** Oakite offers specialized alkaline and acidic type compounds for removing oil, carbon from shell side; lime scale, rust from tube side. Cleaning is done "in-place".

3 **PAINT STRIPPING.** You can strip paint from storage tank exteriors using your own equipment to apply, recover and recirculate stripper. Oakite provides a complete selection of alkaline and solvent strippers.



4 **SALVAGE.** Oakite has simplified methods to make salvage profitable. They give you a choice of specially compounded materials for cleaning and rust-proofing tools, fittings, valves, chains, pumps, etc.

**ON-THE-SPOT SERVICE.** Whenever you have a ticklish problem of cleaning to solve you can get quick on-the-spot advice by reaching for your phone and calling your local Oakite Technical Representative. His services are available at all times. For full particulars drop a line to Petroleum Service Division of Oakite Products, Inc., 52E Rector Street, New York 6, New York.

SPECIALIZED INDUSTRIAL CLEANING

**OAKITE**

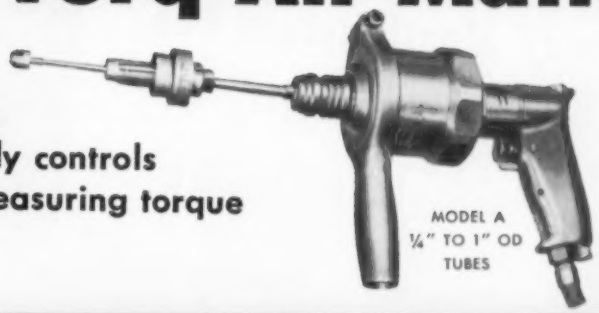
MATERIALS • METHODS • SERVICE

Technical Service Representatives in Principal Cities of U. S. and Canada

**OAKITE PRODUCTS, INC.—General Office: 19 Rector St., New York 6, N. Y.**

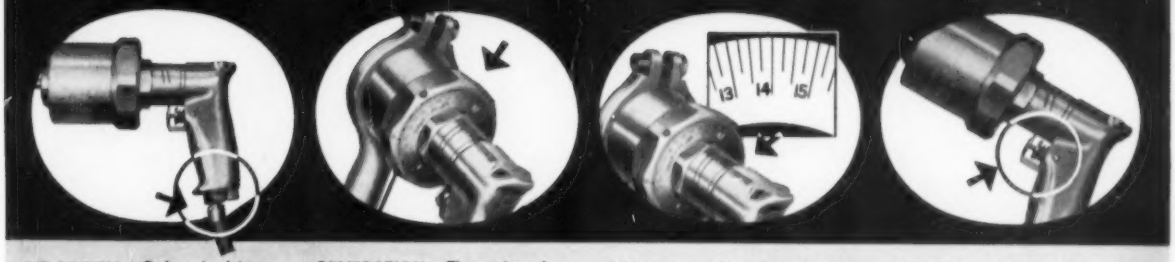
# *New* WILSON Torq-Air-Matic

**First and only air-driven tube expander drive that accurately controls tube expansion by directly measuring torque output at the mandrel.**



MODEL A
¼" TO 1" OD
TUBES

## Look at these exclusive design features of the WILSON Torq-Air-Matic

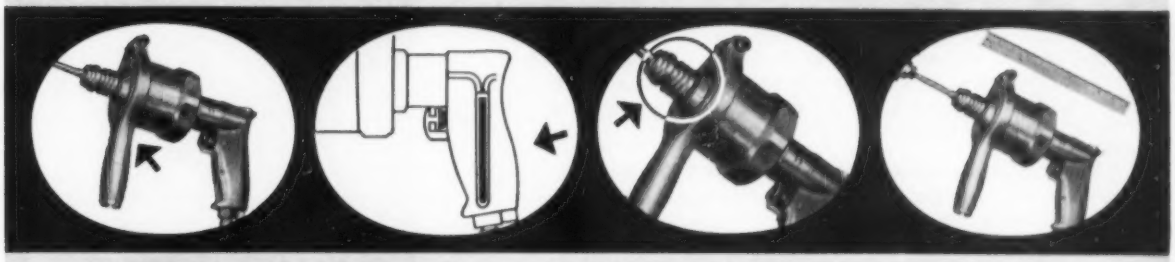



**AIR-DRIVEN**—Only air-driven tube expander drive with a built-in torque control. *Does not require a separate control box, relays or switches.* No extra cables or wires; just one small air hose serves it.

**CALIBRATION**—The only tube expander control calibrated *in terms of foot pounds torque instead of meaningless arbitrary units.* Torque requirements for expanding tubes of off-standard jobs can be more readily arrived at.

**POWERFUL**—Rated to deliver *fourteen foot pounds torque* at 90 psi. This is sufficient to roll 1" OD x 11 gauge boiler tubes.

**SIMPLE**—Only a *single three-position trigger throttle* for off, forward and reverse. Never any danger of over-rolling because of improper sequence of operation. No juggling of switches; nothing new to learn.



**CONVENIENT**—*Furnished with an auxiliary handle that can be swivelled to any position desired* by the operator or left off when the torque reaction is not too great. Basic unit is of a pistol grip design.

**TROUBLE-FREE**—*Has an oil reservoir* built into the handle to supply lubrication to the motor. *The control section is independent of the motor and lubricated for life.*

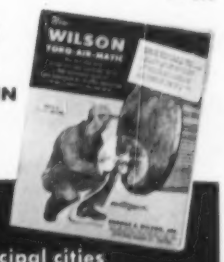
**CHUCK**—*Simple, new type, snap on floating chuck. Only one motion* instantly engages or disengages a square shank mandrel—no set screws.

**COMPACT**—*Only 10" overall* from pistol grip handle to instant action chuck.

TW 850

These features speak for themselves. The Wilson air-driven Torq-Air-Matic tube expander drive and control is an important revolutionary advance in the field of precise tube expanding. Here's what you get when you use the Wilson Torq-Air-Matic control for heat exchanger tubes: (1) uniform and tight pressure joints, regardless of tube sheet hole variation; (2) no over-rolled or under-rolled tubes—no stresses that shorten tube life; (3) extended tube expander life, more production, higher profits.

**SEND FOR BULLETIN 55**




## THOMAS C. WILSON, INC.

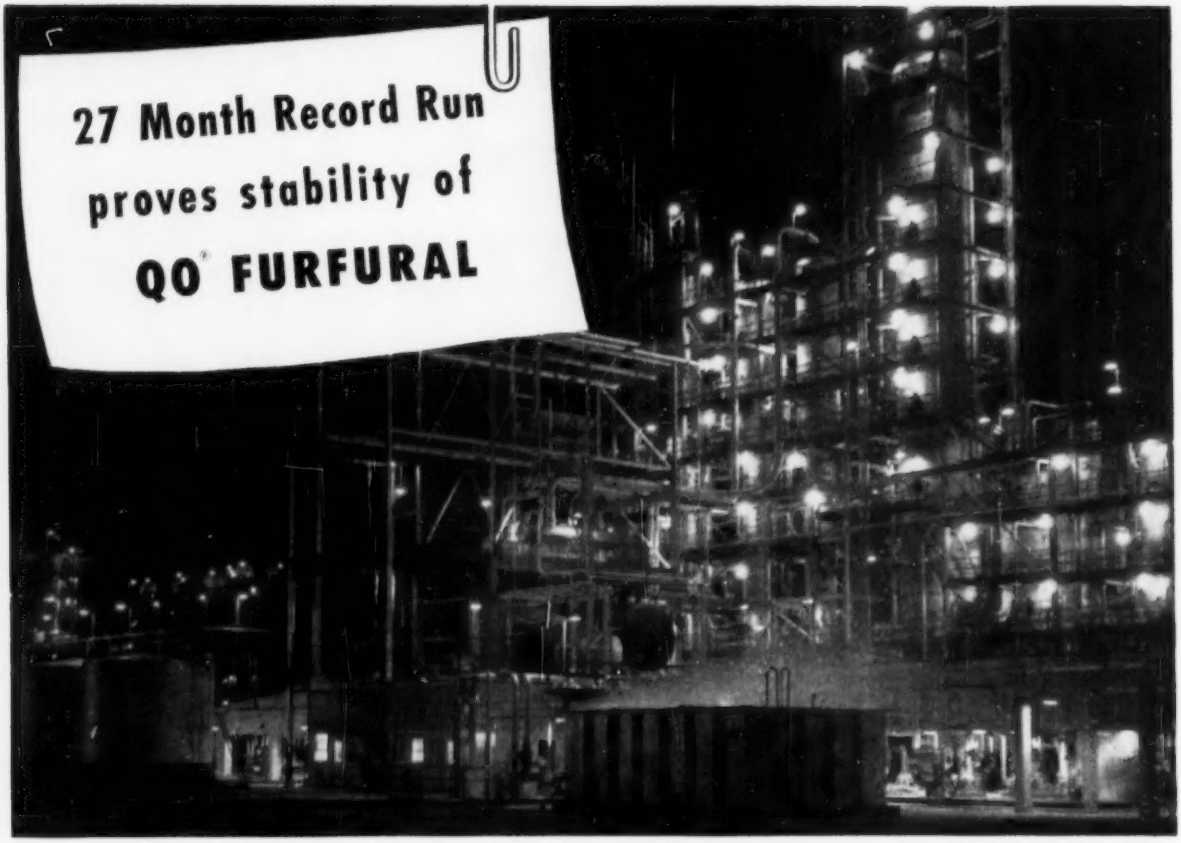
21-11 44th Avenue, Long Island City 1, New York • Representatives in all principal cities

MANUFACTURERS OF TUBE CLEANERS, TUBE EXPANDERS AND TUBE MAINTENANCE TOOLS



For more data on advertised products, use Readers' Service Cards, last page.

# 27 Month Record Run proves stability of QO® FURFURAL



CIT-CON LUBE UNIT . . . 27 MONTHS . . . NON-STOP!

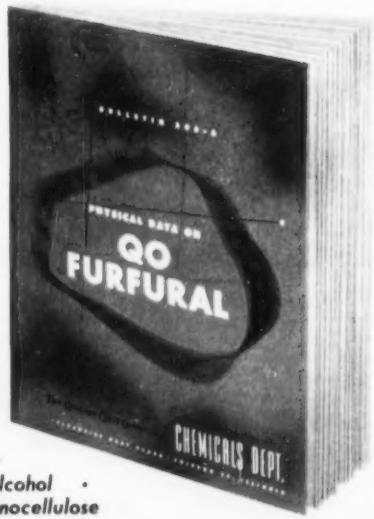
No shutdowns in 27 months! That's how long Cit-Con Oil Corporation ran its furfural lubricating oil unit non-stop . . . using QO furfural as the selective solvent.

We salute Cit-Con engineers. Their operating methods kept Cit-Con's system in good shape all through this run, and capitalized on furfural's stability to produce a continuous flow of high quality lubes.

You can also measure QO furfural's stability by its recovery ratio. In well operated refineries, solvent losses run only 0.02% of the furfural cycled.

No wonder QO furfural is first choice among so many refineries throughout the world. Other reasons? High selectivity. Low cost. Economical storage. Easy handling. Free from excessive toxicity. Year 'round availability.

By all means, write for our helpful new Bulletin 203-A: "Physical Data on QO Furfural." And remember—your Quaker representative is at your service.




*Furfural* • *Furfuryl Alcohol* • *Tetrahydrofurfuryl Alcohol* •
*Furoic Acid* • *Fur-Ag® Conditioner* • *Furafil® Lignocellulose*

**The Quaker Oats Company**

**CHEMICALS DEPT.**

340N The Merchandise Mart, Chicago 54, Illinois
Room 540N, 120 Wall St., New York 5, N. Y.
Room 440N, 3000 No. Going St., Portland 11, Oregon

**In the United Kingdom:** Imperial Chemical Industries, Ltd., Billingham, England • **In Europe:** Quaker Oats-Graanproducten N.V., Rotterdam, The Netherlands; Quaker Oats (France) S. A., 3, Rue Pillet-Will, Paris IX, France; A/S "Ota", Copenhagen, S. Denmark
**In Australia:** Swift & Company, Pty., Ltd., Sydney • **In Japan:** F. Kanematsu & Company Ltd., Tokyo

# *Oil Immersed*

## Safety Line Disconnect Switches

*620 Series*

30 - 60 - 100 - 200 - 400 amp. available for 250 and 600 volt service.

Cutaway view shows unique design of Rowan low-voltage AIR-SEAL fuse for use under oil.

Rowan Series 620 Fused and Unfused Safety Switches are designed to provide dependable service in all locations, especially those where the atmosphere is corrosive, as in chemical plants, oil refineries, steel or cement mills.

Switches are supplied with cast iron tops and welded steel tanks; special floor-mounted units are made of high quality steel. Enclosures are NEMA Type XI . . . also available in NEMA Type VIII in which all electrical connections are at least six inches under oil.

Standard features of these units include the following: completely oil immersed; equipped with Rowan time-tested AIR-SEAL fuses; disconnect switch of the quick-acting contactor type with renewable contacts; top and tank mechanically interlocked with disconnect switch to prevent lowering of tank when switch is in the closed position; provision for padlocking disconnect switch in OFF position; weather resistant enclosing case; provision for lowering tank for inspection without removing tank.

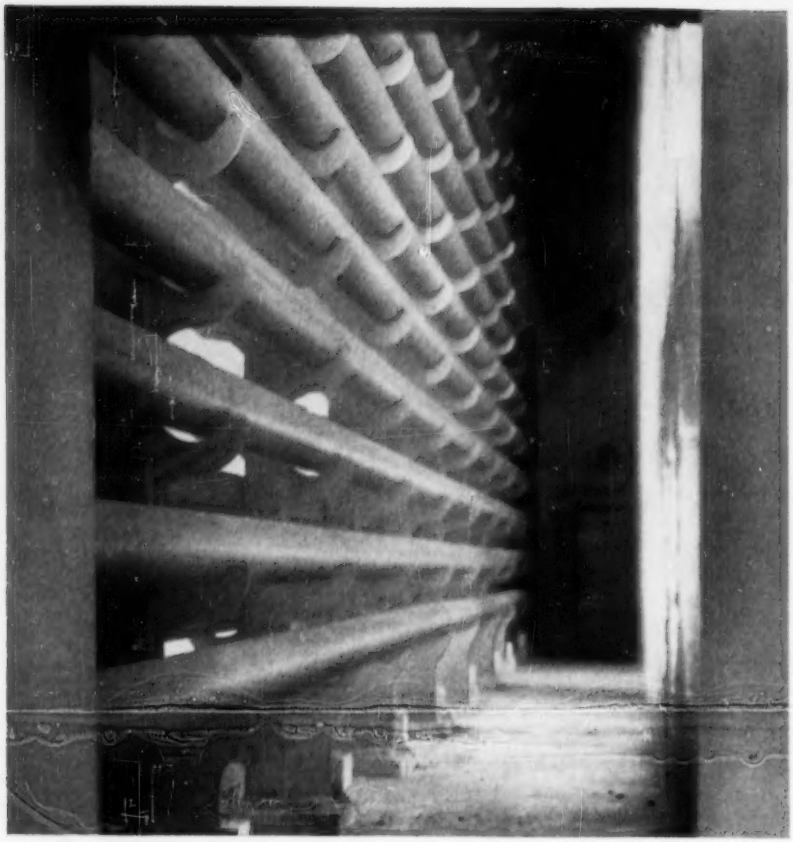
Complete information available from Rowan representatives located in principal cities throughout the country.

# ROWAN CONTROL

## THE ROWAN CONTROLLER CO., BALTIMORE, MD.

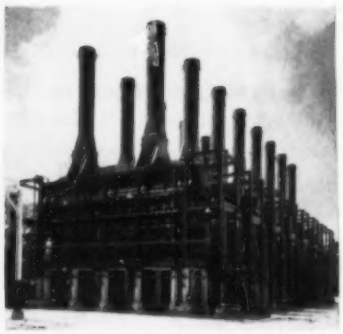


For more data on advertised products, use Readers' Service Cards, last page.



**Incoloy tubes on firing line** — In the reaction zone of the Selas furnace, lowest and hottest area, 18 Incoloy tubes carry the stream. Maintenance is very slight.

**Battery of 8 Selas cracking furnaces** producing ethylene at Gulf Oil's new No. 2 unit from ethane or propane. Independent regulation of banks of burners controls temperature and compensates for wide variations in feed stock composition. Absence of open flame permits compact construction and promotes uniform heating . . . adding to tube life and reducing coking.



# Incoloy furnace tubes safeguard ethylene supply

## *. . . aid production continuity in million pound/day* Gulf *plant*

Ethylene is as basic as bread to the petrochemical industry. Continuous, reliable supply is essential.

That's why Gulf Oil Corporation's completion of the No. 2 Unit in its Port Arthur plant is sparking petrochemical development in Texas' Gulf Coast.

### New facility assures ethylene at million pound/day level

At the feed end, Gulf's own big nearby refinery is a stable source of ethane and propane. At the distribution end, extensive, highly flexible ethylene storage and pipeline facilities keep product availability at a steady high level.

So does the plant itself. It is designed for maximum continuity of production.

Take the tubes in the cracking furnaces, for example. In the high temperature reaction zone, they are Incoloy* iron-nickel-chromium alloy.

Under prolonged exposure to such conditions, Incoloy alloy is stably austenitic and shows excellent resistance to carburization — providing a factor of safety during decoking if temporary hot spots were to develop.

Speaking of No. 1 Unit, Gulf states: "*These tubes have been in actual cracking service over 9000 hours. Maintenance has been very slight . . . mainly replacing one or two feet at the outlet end of several tubes.*" (An easy repair with weldable Incoloy.)

As a result of this experience, Gulf is using 72,000 pounds of Incoloy alloy tubing in the reaction zones of the battery of the 8 new Selas furnaces.

### As an extra bonus . . .

Gulf realizes a distinct price advantage in using Incoloy tubing in the relatively inexpensive extruded form.

If the selection of furnace tube materials is your responsibility, you will want to know the advantages of Incoloy. It's easy to get the facts. Just write Inco's Development and Research Div.

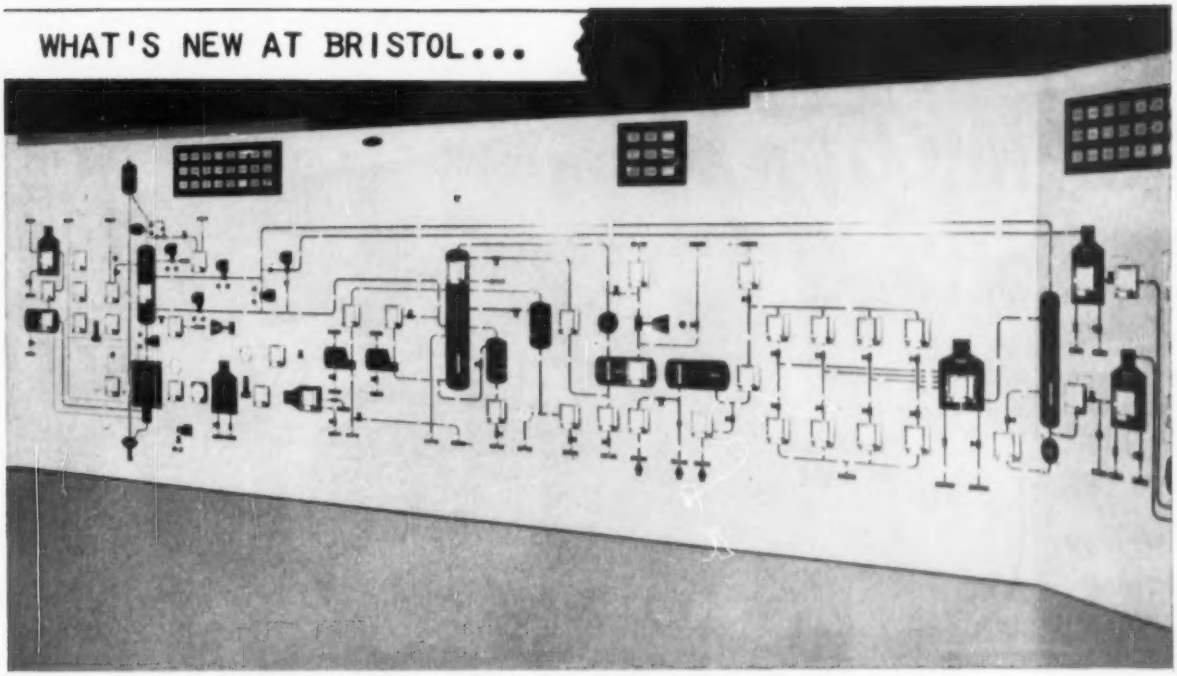
*Registered trademark of The International Nickel Company, Inc.

**The INTERNATIONAL NICKEL COMPANY, Inc.**
67 Wall Street New York 5, N. Y.

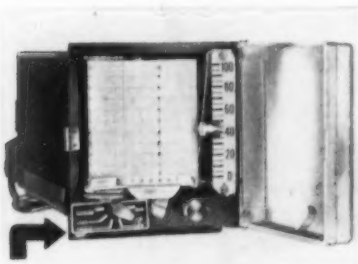
INCO TRADE MARK

**Incoloy . . . *for heat-resisting use***

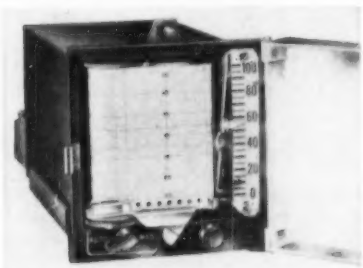
WHAT'S NEW AT BRISTOL...



**TYPICAL GRAPHIC PANEL** of Bristol Metagraphic instruments in oil refinery.



**SIX-POSITION TRANSFER VALVE** (on one knob) for cascade control.



**THIS METAGRAPHIC TWO-PEN RECORDING RECEIVER** records, indicates and controls one variable, and records another. It gives a continuous indication of either set-point or valve-position and indicates the other when valve knob is depressed.

# Bristol's Metagraphic Receiver line

## gives you 35 models to choose from

### A new degree of performance flexibility in a pneumatic receiver

Bristol's Metagraphic Receiver is offered for up to 3 measured variables – choice of three- or six-position transfer valves on one knob.

**Full plug-in construction** provides a flexibility of use that can't be matched. You can change a recorder to an indicator or vice versa in less than 10 seconds. If trouble is suspected, the unit can be replaced by a spare, checked in the shop – eliminating down time.

**The chassis** of a Metagraphic Receiver can be withdrawn to an intermediate position while still operating. In this position, receiver can be inspected, charts changed, pens inked, zero adjusted, and clock serviced.

**Continuous valve position indication** on same scale as set point. "Bumpless" transfer is effected simply by matching pointers – no need to read scales.

**High-visibility** colored fluorescent paints make pointers easy to tell apart. Pointers for a given function are the same color in all instruments.

**Air chart drives** are 100% pneumatic – no electricity needed. Operates from 20 psi air supply.

**Universal piping manifold** can be adapted to any piping (2-pipe or 4-pipe system). No special tools, no parts required.

Write for the Bristol Metagraphic Receiver bulletin. The Bristol Company, 111 Bristol Road, Waterbury 20, Conn. 5.43

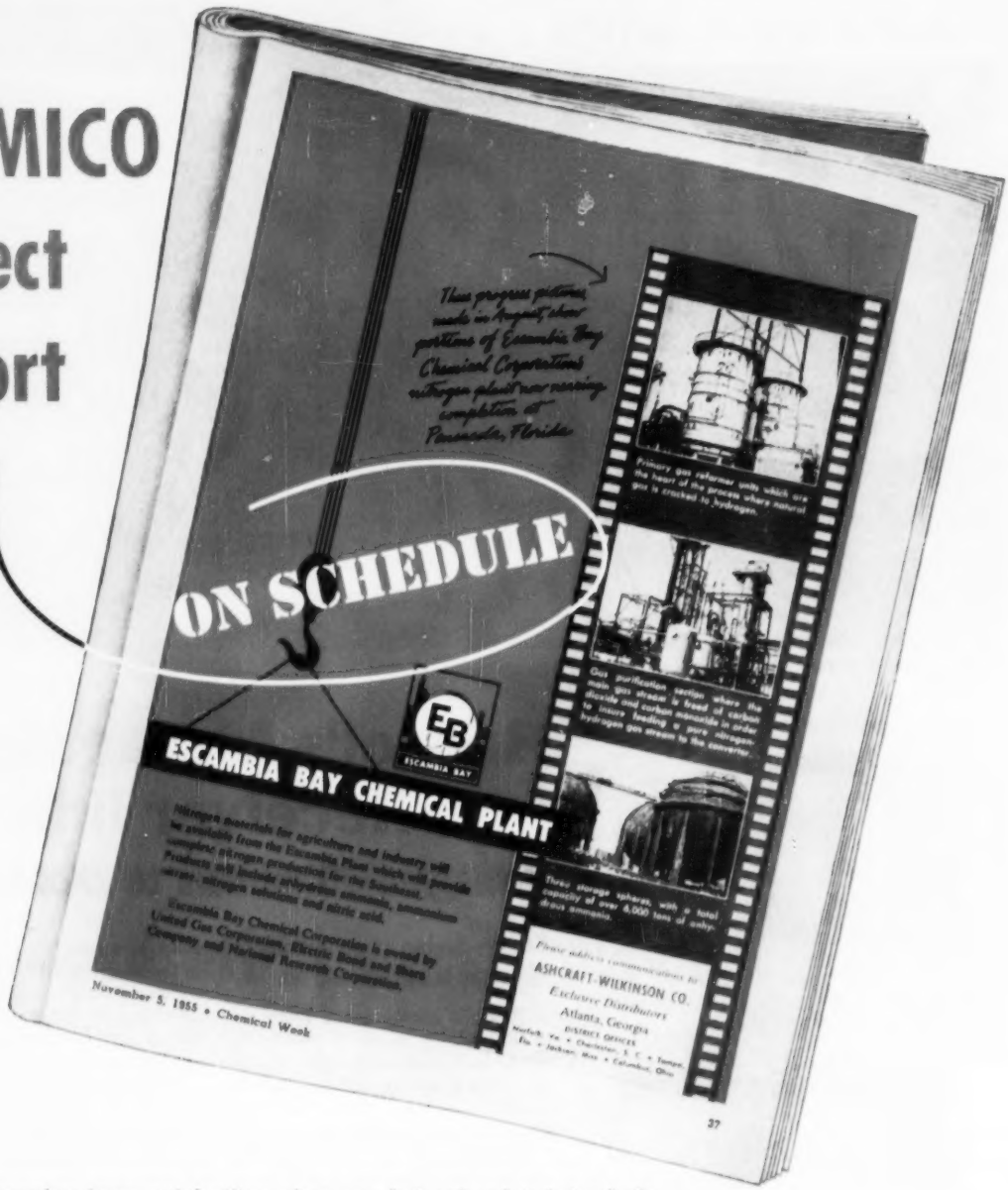
BRISTOL'S

# BRISTOL

*POINTS THE WAY IN HUMAN-ENGINEERED INSTRUMENTATION*

**AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS**

# A CHEMICO Project Report


These progress pictures, made in August, show portions of Escambia Bay Chemical Corporation's nitrogen plant now nearing completion at Pensacola, Florida
ON SCHEDULE
ESCAMBIA BAY CHEMICAL PLANT
Primary gas reformer units which are the heart of the process where natural gas is cracked to hydrogen.
Gas purification section where the main gas stream is freed of carbon dioxide and carbon monoxide in order to insure leading a pure nitrogen-hydrogen gas stream to the converter.
Three storage spheres, with a total capacity of over 4,000 tons of anhydrous ammonia.
Nitrogen materials for agriculture and industry will be available from the Escambia Plant which will provide complete nitrogen production for the Southeast. Products will include anhydrous ammonia, ammonium nitrate, nitrogen solutions and nitric acid.
Escambia Bay Chemical Corporation is owned by United Gas Corporation, Electric Bond and Share Company and National Research Corporation.
Please address communications to
ASHCRAFT-WILKINSON CO.
Exclusive Distributors
Atlanta, Georgia
DISTRICT OFFICES
November 5, 1955 • Chemical Week
37

This complete integrated fertilizer plant was designed and is being built by CHEMICO for Escambia Bay Chemical Corporation of Pensacola, Florida.

It will have a capacity of 200 tons per day of ammoniated nitrate solution and 350 tons per day of coated and pelleted ammonium nitrate to serve the Southeast.

The schedule calls for start-up 15 months after award of the job and only 13 months after the initial purchases of equipment and materials.

**CHEMICAL CONSTRUCTION CORPORATION**

A UNIT OF AMERICAN CYANAMID COMPANY

*Designers and constructors of complete plants and facilities for the chemical, metallurgical and petrochemical processing industries for over 40 years*

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*Cable Address: Chemiconst, New York • Technical Representatives: Cyanamid Products Ltd., London*
*South African Cyanamid (Pty) Ltd., Johannesburg*

CC 288

# GENERAL REFRACTORIES

## better health . . . because of BRICK

It is hard to associate X-rays with brick—the refractory brick which contains the fires of industry. Yet, were it not for brick these fine X-ray machines would never be made, and there'd be no electricity to operate them.

From an autoclave to an automobile, from a scalpel to a skyscraper, everything that's made and every form of transportation, communication and power owe their existence to refractory brick.

Our job is to provide that brick. In infinite variety. Compounded to formulas as precise as a prescription, in the world's largest refractories research laboratory. Moulded from materials brought from many countries in plants strategically located across our country to serve industry swiftly . . . dependably . . . economically . . . everywhere.

GENERAL REFRACTORIES COMPANY
Philadelphia 2

### A COMPLETE REFRACTORIES SERVICE FOR THE PETROLEUM INDUSTRY

**LITECAST 50**—A hydraulic-setting insulating castable refractory material, having a density of approximately 50 lbs. per cubic foot. Its extreme light weight and exceptionally low thermal conductivity make it an efficient and economical heat insulator. Recommended for vessel linings and backing for brickwork for other heavier castable refractory materials.

**HIGH-STRENGTH BRIK-CAST**—A hydraulic-setting castable refractory material unique in that it contains more bonding agent, which results in a product more resistant to the physical actions of impact, erosion, and load bearing. Used extensively for lining regenerator chambers and catalyst lines in catalytic cracking units.

**LITECAST 50-M**—A 50-pound density insulating castable, having a high degree of purity, used as a liner in vessels and lines where atmospheres must be controlled, or contamination of internals must be avoided. LITECAST 50-M may be applied in the same manner as standard hydraulic-setting castables.

**BRIK-CAST 3000**—A hydraulic-setting castable refractory material, composed of clays and bonding agents having the highest purity, resulting in a product with a high operating temperature (3000° F.), and resistance to reducing atmosphere in carbon monoxide attack. Recommended for sulphur burner chambers and other vessels operating above normal cracking and reforming temperatures.

# STAYNEW FILTERS

Dollinger makes ALL TYPES of filters as shown on this page, plus special filters for unusual filtration problems. New users of one specific type of Staynew filters often find a second Dollinger filter performs a great, added service in other processes or operations. Perhaps we can serve major or other filtration needs of your plant.

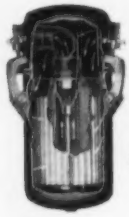
## LIQUID FILTERS

Model HE (Sump) Liquid Filter Bulletin 330

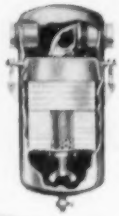
Model ELS (Pressure) Liquid Filter Bulletin 300

## PIPE LINE FILTERS

Model CPH Pipe Line Filter Bulletin 200



Model CVH (Vacuum) Pipe Line Filter Bulletin 200



Model AAPHS (Absorption) Pipe Line Filter Bulletin 200

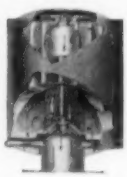
Model HPH and AHPH (High Pressure) Pipe Line Filter Bulletin 200

## all types of FILTERS for every INDUSTRIAL NEED

## AIR INTAKE FILTERS

Model IDR (Ground Level) Air Intake Filter Bulletin 100

Model DS (Silencer) Air Intake Filter Bulletin 100



Model D (Outdoor) Air Intake Filter Bulletin 100

Model C (Indoor) Air Intake Filter Bulletin 100

## VENTILATION FILTERS

Electro-Staynew Mist Collector Bulletin 420

Electro-Staynew Precipitator Bulletin 400

Automatic Ventilation Filter Bulletin 500

Dry and Viscous Panel Ventilation Filters Bulletin 600 and 700

DOLLINGER PROTECTOMOTOR STAYNEW FILTERS

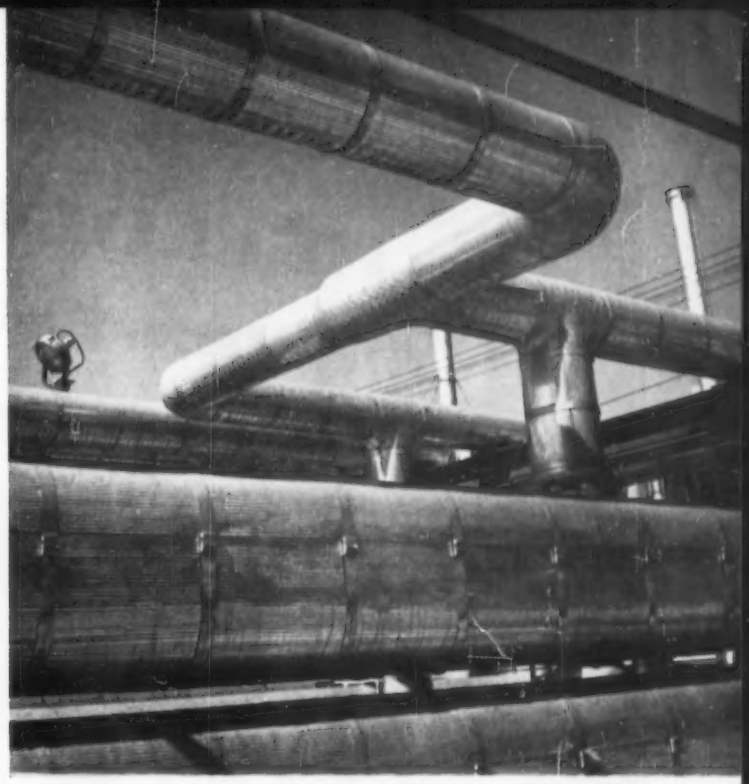
DOLLINGER CORPORATION CENTRE PK. ROCHESTER 3, N. Y.

**Write,** using Bulletin Numbers, for complete information on any of the Staynew filters illustrated. Consult Dollinger engineers on any special filtration problems—no obligation. Dept. 47 Centre Park, Rochester.

LIQUID FILTERS, PIPELINE FILTERS, INTAKE FILTERS, HYDRAULIC FILTERS, ELECTROSTATIC FILTERS, DRY PANEL FILTERS, VISCOUS PANEL FILTERS, LOW PRESSURE FILTERS, HIGH PRESSURE FILTERS, AUTOMATIC VENTILATION FILTERS, NATURAL GAS FILTERS, SPECIAL DESIGN FILTERS, SILENCER FILTERS

# How Olin Mathieson Uses Childers Jacketing For Insulated Lines

**Jacketing problems at new plant ranged from covering tall towers to irregularly-shaped heat exchangers. Read how aluminum jacketing solved these problems.**



**More than 244,000 square feet** of Childers .006" Jacketing and 35,000 square feet of heavy weight Childers Jacketing was used in this new Olin Mathieson plant to weatherproof insulated lines, towers and vessels. Close-up above shows how aluminum jacketing was applied with strapping and seals.

**Low first-cost,** long life, and easy installation were the big reasons Olin Mathieson Chemical Corporation used Childers Aluminum Jacketing for outdoor insulated lines in their new Brandenburg, Ky., petrochemical plant.

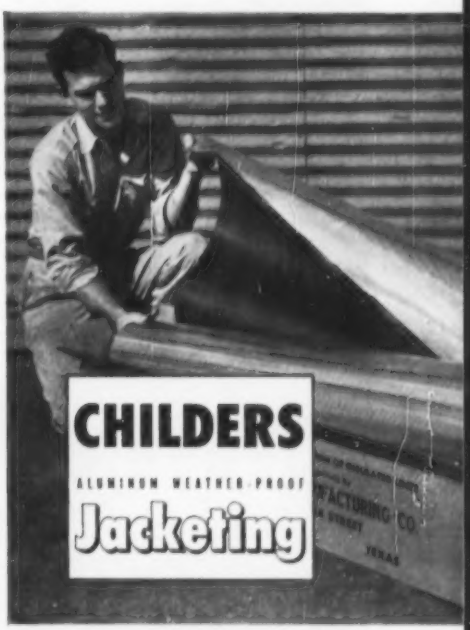
**Mathieson used Childers** standard weight Jacketing on their insulated lines. Heavier weights of Childers Jacketing were used on high towers and vessels where a stiffer material was needed to support the vertical weight of the jacketing.

**Engineers report** that Childers Jacketing is inexpensive to apply. It comes in easy-to-handle rolls 4 ft. wide and 100 ft. long. Just pliers and a pocketknife are the only tools needed to apply. And because the jacketing is aluminum it needs no painting . . . stays clean and new looking even after years of service.

**Childers Jacketing** is easily removable, too. Just remove the strapping and jacketing can be taken off for inspection of the lines. Then same jacketing can easily be put back on the insulated line.

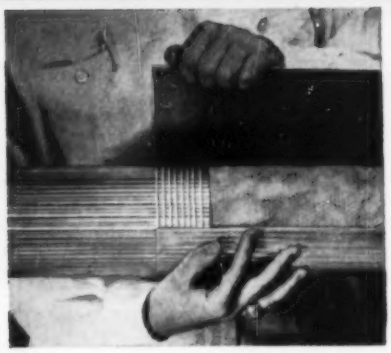
**Immediate shipment** from our large factory stocks can eliminate costly delays in construction or plant improvement schedules.

**Try this low-cost protection** in your plant. Write today for engineering data and information. You can order a 400 sq. ft. roll to test on one of your insulated lines. No obligation. Address: Childers Manufacturing Company, Department PR - 30, 3620 West 11th St., Houston, Texas.




**Each roll of Childers Jacketing** comes individually packed like this in a heavy corrugated carton. Rolls are 4 ft. wide. With moisture barrier attached they are 100 ft. long; without moisture barrier they are 200 ft. long. They are well protected for field storage if kept dry. Individual boxes are light enough for one man to handle. (Adv.)

## Only Childers Jacketing Offers *LAP-SEAL*

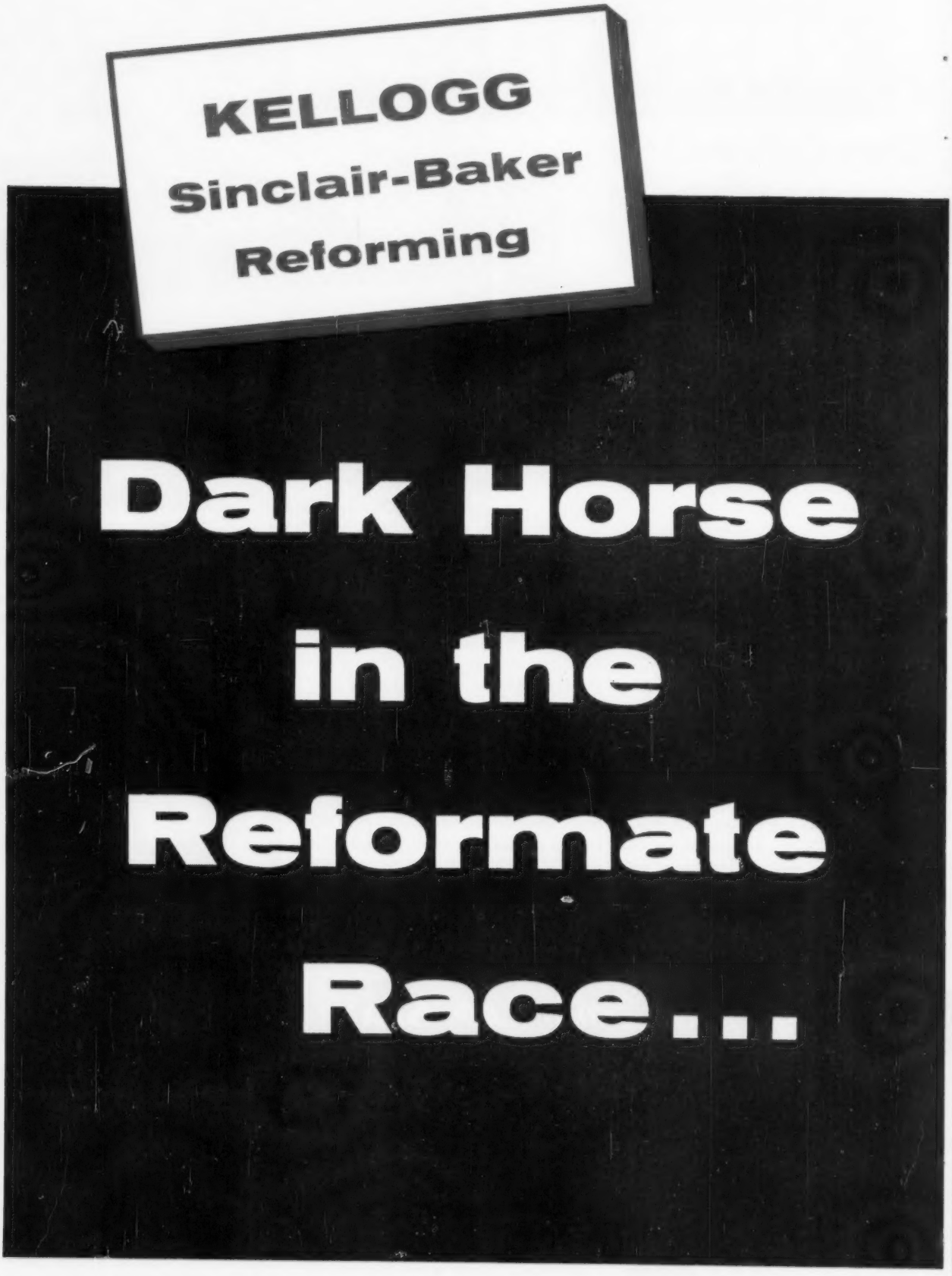


***LAP-SEAL*** **is a series of eight ribs rolled into the underlapping edge of the jacketing.**

***LAP-SEAL*** **makes more positive weather seal.**

***LAP-SEAL*** **saves labor—2" ribbed edge eliminates measuring for circumferential lap.**

***LAP-SEAL*** **(patent applied for) is an exclusive "plus" available on all Childers Jacketing at no extra cost.**







For more data on advertised products, use Readers' Service Cards, last page.

# New Process and New Catalyst Promise New Records in Production of Low Cost, High Octane Reformates

Although the M.W. Kellogg, Sinclair-Baker process is still too new in service to provide any long-term performance data, and customers' initial findings cannot yet be disclosed, many economic advantages of this catalytic naphtha reforming process have already been firmly established. Any refiner faced with increasing octane yields from present feedstocks, or with getting high octane reformates from lower grade naphthas, will recognize the significance of the following points . . .

### Quick Start-Up

Experimental operation is reduced to a minimum. One M. W. Kellogg reforming unit was started on its final test run within two weeks after the catalyst was first charged to the reactors—with octane rating and yield during this 15-day period well in excess of the guarantee.

### A Regenerative Catalyst

Sinclair-Baker Platinum Catalyst RD-150 can be regenerated easily and quickly *in situ* to provide many operating cycles, each of many months duration, with negligible loss in catalyst activity. Cost of catalyst per pound in terms of barrels of reformate produced is a major economic factor of the process.

### Long Catalyst Life

Sinclair-Baker regenerative catalyst RD-150 has high activity and long initial life. It has been in operation for over one year without supplementing the catalyst. 95 octane reformate can be produced for six months or longer before regeneration is required.

### Octane Level

Depending on the feedstock, clear octane ratings above 90 are now being obtained commercially—with 100, and even better, a goal that is entirely feasible and economically practical. *Variability* of octane rating is the keynote of the process, permitting selection of the exact processing conditions for a given naphtha to secure optimum economic operation at all times.

### Supply of Catalyst

Use of the process does not obligate refiners to buy Catalyst RD-150 beyond the first year's requirements, although a continuing source of supply can be assured. This freedom from long-term purchase and license agreements is an important consideration when deciding which is the most suitable reforming process.

### Low Grade Naphtha Feeds

M. W. Kellogg's unique design permits the effective desulphurization of low grade naphthas as part of the process, and avoids corrosion and metal contamination. Kuwait naphthas thus treated, for example, can produce yields of high octane reformates only slightly lower than those for higher grade Mid-Continent feedstocks.

### For More Information

Further details on M. W. Kellogg's catalytic naphtha reforming process, the Sinclair-Baker catalyst, together with some economics of both, are contained in a recent booklet, "Low Cost Production of 95 Octane Clear Reformate." Copy sent on request.

*Refinery Process Division*

**THE M. W. KELLOGG COMPANY**

225 Broadway, New York 7, N. Y.

*The Canadian Kellogg Company, Ltd., Toronto • Kellogg International Corp., London*

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For more data on advertised products, use Readers' Service Cards, last page.

# NEW!

Porous stainless steel (15-diameter magnification)

# Cuno PORO-KLEAN filter stops 3-to 30-micron particles at 900°F

Cuno's new PORO-KLEAN offers true micronic filtration at temperatures that melt tin, bismuth, cadmium, lead or zinc.

High temperatures, high viscosity, high pressure drops and corrosive fluids don't faze this new filter.

**It's all metal**—absolutely lint-free. There's no contamination of the filtered fluid.

**It's strong.** PORO-KLEAN filters already in operation take a pressure drop of 1500 psi. PORO-KLEAN porous stainless steel has been used for structural parts in aircraft to achieve boundary layer control and transpiration cooling.

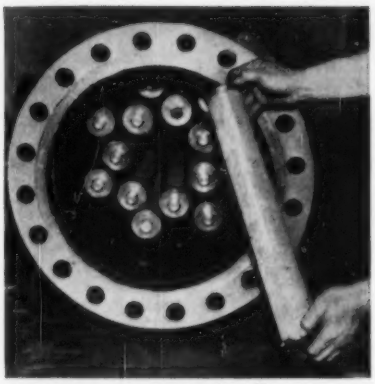
**It's corrosion resistant.** Standard in 316 stainless steel. Low carbon content (0.03 to 0.05% max.) prevents carbon precipitation at welds or during fabrication.

**It's easily cleaned**—in place, by backwashing with pre-filtered fluid or inert gas; or, when removed, with suitable solvent. May be sterilized with live steam for food or drug processing; or will filter rust and scale from steam used for other cleaning or sterilizing.

**Its porosity is closely controlled.** Four standard grades cover the range from 3- to 30-micron statistical particle retention.

**Standard designs.** For most applications standard housings and elements are available.

**Get all the facts** on Cuno's new PORO-KLEAN filter for your chemical or process applications. Write Cuno Engineering Corporation, 34-1 South Vine Street, Meriden, Conn. 5.3



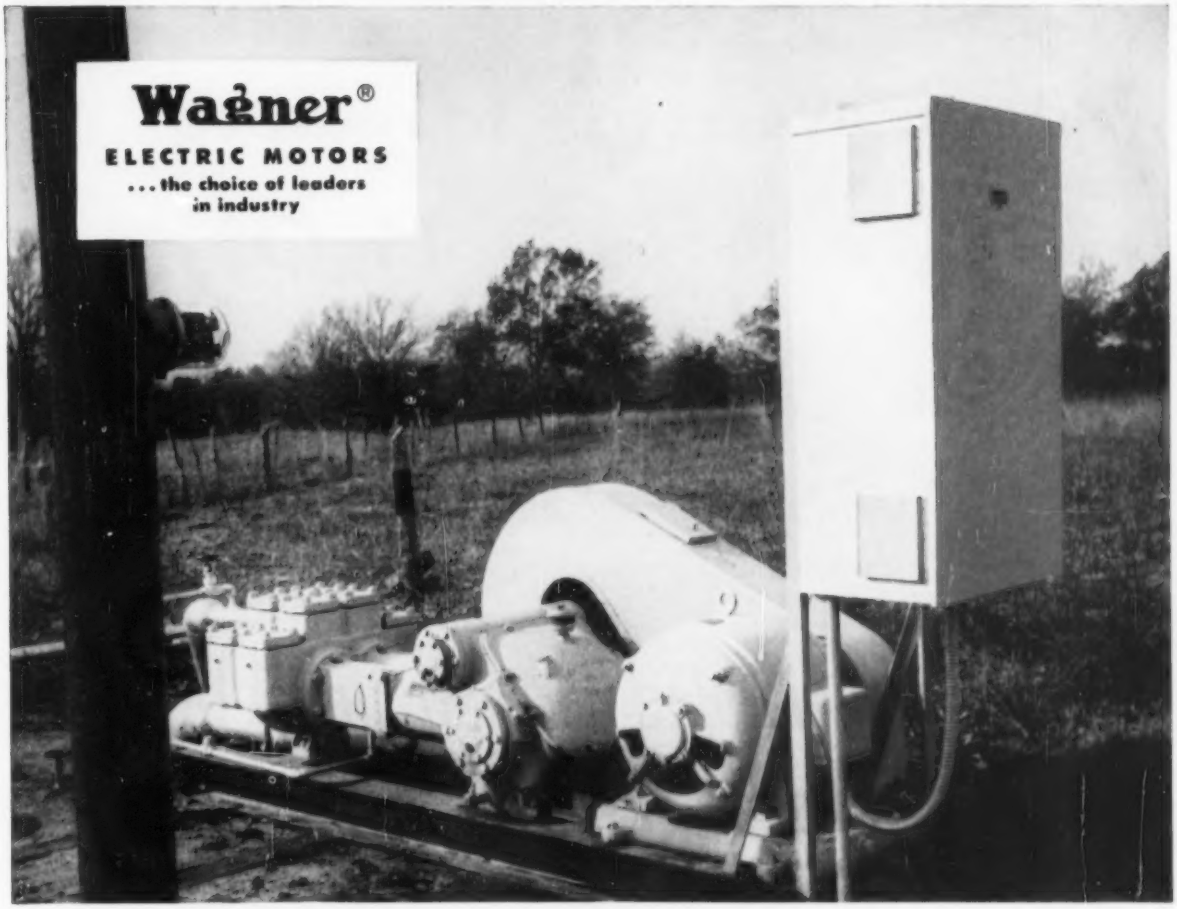
**THIS PORO-KLEAN FILTER** handles 180 gpm of naphtha at 400°F. Operating pressure: 700 psi ASME Code with 5 psi pressure drop. It's cleaned by back-flushing with nitrogen. Cell-type PORO-KLEAN filter elements (large picture at top) have large surface area. This unit is 54" L x 9" O.D. and is designed for 1500 psi pressure drop and 550°F.

CUNO

## ENGINEERED FILTRATION

**Removes More Sizes of Solids From More Kinds of Fluids**

**AUTO-KLEAN (edge-type) • MICRO-KLEAN (fibre cartridge) • FLO-KLEAN (wire-wound) • PORO-KLEAN (porous metal)**




# portable power for the petroleum industry

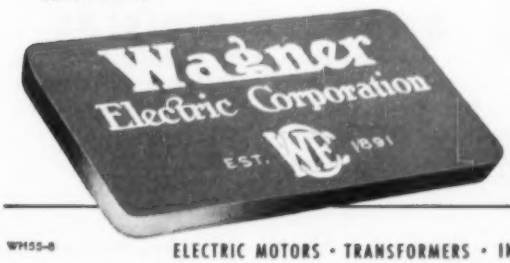
American Oil Pipe Line Company pipes crude oil from lease tanks to storage tanks of oil refineries. The network of pipe in a field is called a "gathering system."

At various gathering system locations, you'll find gathering pumps which keep the heavy crude oil coursing through the pipeline. These gathering pumps are put on skids so they can be moved about to give the system greater flexibility. American can move its pumps quickly and easily whenever new pipe is added or old pipe is abandoned.

A 25 horsepower Wagner motor is the hard-working heart of each of these portable pumps. Wagner motors are chosen for this application because they go about their ceaseless job of hurrying crude oil to the refinery with complete dependability and a minimum of maintenance.

Perhaps you have a specialized motor application . . . if so, remember, there's a Wagner motor to fit every need . . . a complete line for all current specifications with a wide variety of enclosure types and mountings.

Your nearby Wagner engineer can help you select the *right* motor to meet your specifications. Call the nearest of our 32 branch offices or write us.




**Wagner Electric Corporation**
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WH55-8

ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES • AUTOMOTIVE BRAKE SYSTEMS—AIR AND HYDRAULIC

to remove

$H_2S$

$CO_2$

use

*Monoethanolamine*

*Diethanolamine*

high purity
**NITROGEN DIVISION**
chemicals

**Maximize the purity** of your gas stream, and minimize corrosion problems by using Nitrogen Division gas-treating chemicals. Free of unwanted chemical impurities – chlorides and acids – these products are consistently above standard purity specifications.

**Call or write** today for samples and quotations. Ask too for technical service to help adapt these high purity chemicals to your process.

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ALLIED CHEMICAL & DYE CORPORATION
**40 Rector Street, New York 6, N. Y.**
**Hopewell, Va. • Ironton, Ohio • Orange, Tex. • Omaha, Neb.**

to remove

$H_2O$

use

*Diethylene Glycol*

*Triethylene Glycol*

high purity
**NITROGEN DIVISION**
chemicals

**Maximize the purity** of your gas stream, and minimize corrosion problems by using Nitrogen Division gas-treating chemicals. Free of unwanted chemical impurities – chlorides and acids – these products are consistently above standard purity specifications.

**Call or write** today for samples and quotations. Ask too for technical service to help adapt these high purity chemicals to your process.

**NITROGEN DIVISION**
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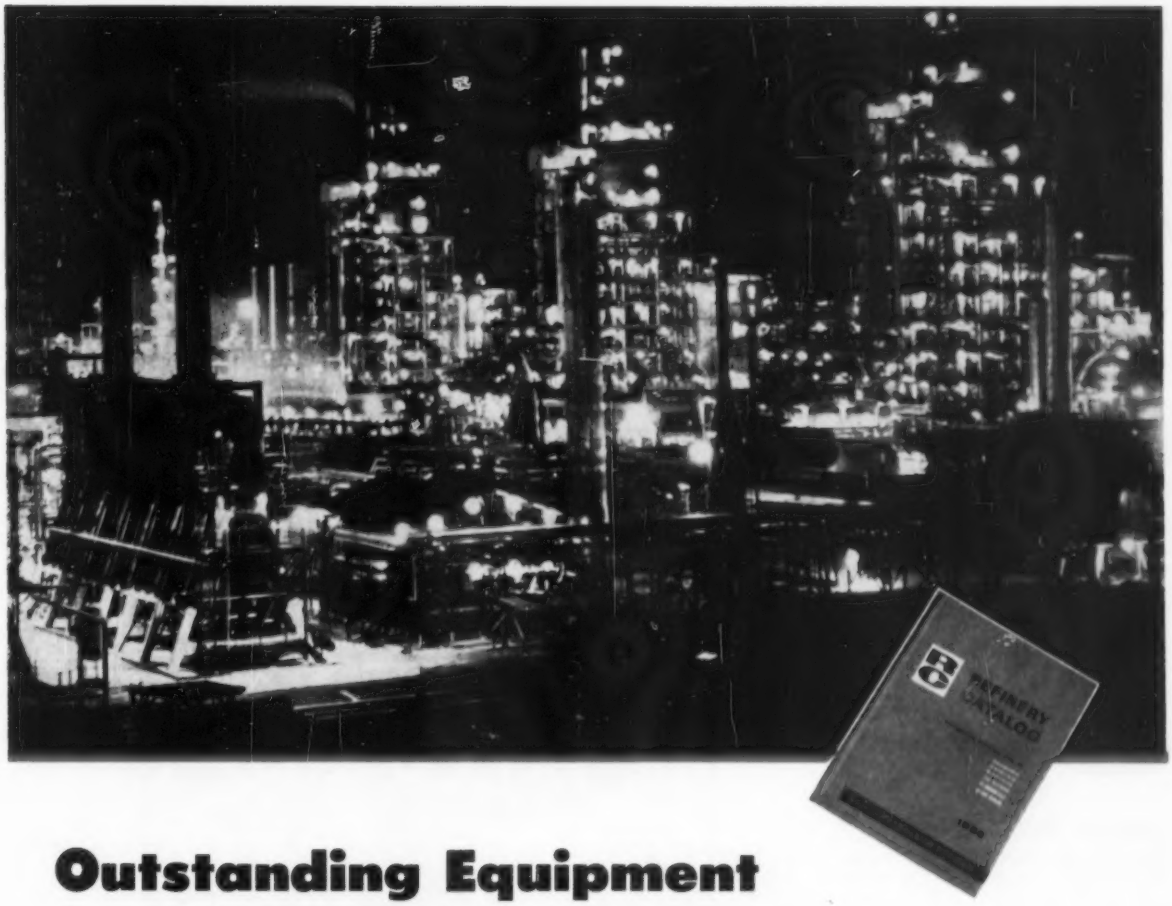
Ethanolamines • Ethylene Oxide • Ethylene Glycols • Formaldehyde • Nitrogen Tetroxide
Nitrogen Solutions • U.F. Concentrate—85 • Fertilizers & Feed Supplements




# Outstanding Equipment for the Petroleum Industry . . .

Advance Design
+
Successful Engineering
+
Craftsman Manufacturing
+
Outstanding
National Service
**TOTAL**
Economical
Dependable Performance

**16 Pages of Condensed Product Descriptions appear in the 1956 Refinery Catalog pages 901 to 916**

- Centrifugal Pumps
- Steam Pumps
- Power Pumps
- Rotary Pumps
- Steam Jet Ejectors
- Multi-V-Drives
- Hydraulic Decoking Equipment
- Air and Gas Compressors
- Oil, Gas, Dual Fuel Engines
- Steam Turbines and Turbine Generators
- Refrigeration and Dewaxing Equipment

*Keep your eye on*

**WORTHINGTON**

GENERAL OFFICES
HARRISON, NEW JERSEY


For more data on advertised products, use Readers' Service Cards, last page.

# 3 reasons why

## YOU SHOULD CALL TRECO...

**1**

**UNIFIED RESPONSIBILITY**

Treco service is complete — from drafting board to test run. We start with the knowledge of your requirements or from your specifications and furnish a complete operating schedule.

**2**

**SOUND ENGINEERING**

Experienced engineers — Process, Mechanical, Electrical, Chemical, and Civil Engineers — assure sound engineering, design and erection, eliminating costly oversights and delays.

**3**

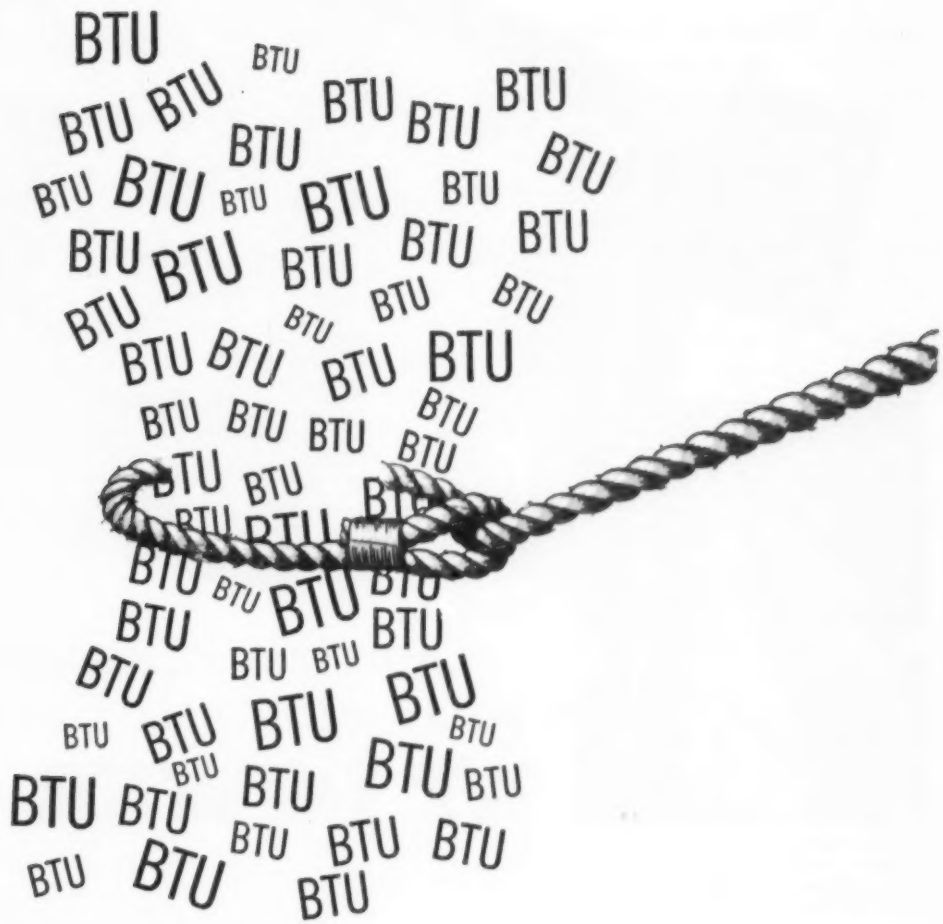
**ECONOMY**

Sound engineering, plus experienced construction personnel, plus plenty of good equipment assures economical, speedy construction. TELEPHONE, WIRE OR WRITE US BEFORE YOU BUILD OR REVAMP.

TRECo

**REFINERY ENGINEERING** *Company*

**TULSA** **TORONTO**



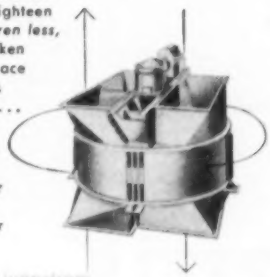

# cut fuel costs

## *you can save one barrel in every five with the Ljungstrom® Air Preheater*

**HOW FAST IS "WRITE OFF"?**

**In fuel savings alone, most refiners write off the cost of the Ljungstrom installation in twelve to eighteen months. This time is cut to *nine months and even less,* when the other Ljungstrom advantages are taken into account — permits more economical furnace design, with no need for convection surfaces . . . burns many fuels you used to throw away . . . results in consistently higher through-put . . . boosts product quality . . . and minimizes slag.**

**For more complete details on what the Ljungstrom Air Preheater can do for you . . . for an analysis of the heat-recovery benefits attainable in fuel burning equipment — call or write The Air Preheater Corporation.**



**The Ljungstrom operates on the continuous regenerative counterflow principle. The heat transfer surfaces in the rotor act as heat accumulators. As the rotor revolves, the heat is transferred from the waste gases to the incoming cold air.**

How much fuel do your process units burn *just to keep the stacks hot?* It takes precious BTU's to keep them as hot as they are . . . BTU's that, if recaptured, would be working for you — instead of costing you money.

With the Ljungstrom, much waste heat is recovered from exit gases, transferred to incoming combustion air and funneled back into the furnace. How much fuel does this save? You get an idea when you consider that for every 45-50°F of preheat, your fuel bill drops 1% — and Ljungstrom Air Preheaters now in use preheat air to over 1,000°F.

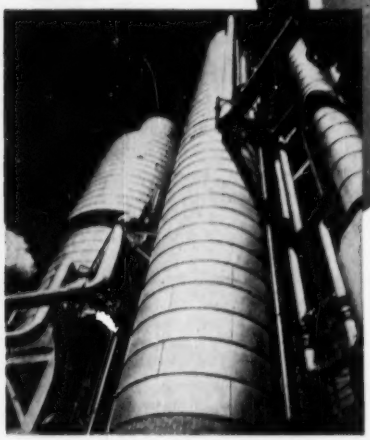
That's why a Ljungstrom saves you up to 20% of your fuel costs — *one barrel in every five.* In fact, one midwestern refiner reports $74,200 saved in fuel in one year. And after he subtracted the Ljungstrom operating cost, he still wound up the year $64,800 ahead.

**The Air Preheater Corporation** **60 East 42nd Street, New York 17, N. Y.**



For more data on advertised products, use Readers' Service Cards, last page.

STRUCTURAL STABILITY—
Low-cost carbon steel backing provides necessary strength and rigidity.
DESIGN FREEDOM—
Integral bond allows design and fabrication of shapes to meet process and space needs.
ECONOMY—
High-alloy layer assures corrosion resistance, long equipment life.



*Stainless-clad and monel-clad steels combine to handle corrosive asphalt crude containing up to 2.5% sulfur concentrations at 750° F in this vacuum still.*

# CLAD STEEL EQUIPMENT GIVES SOLID HIGH-ALLOY PROTECTION AT LOWER COST

With protection against the corrosive action of sulfuric feeds at high temperatures a "must" to avoid unscheduled shutdowns, clad steel equipment is often the *economical* answer. Cladding and backing are permanently and integrally bonded over their entire surface, eliminate the chance of seepage or crevice corrosion. Smooth, uniform clad surfaces permit easy cleaning, drainage and inspection.

Why not investigate clad for your new processing equipment. Lukens Clad Steels—stainless, nickel, Inconel, Monel, copper—give you all the advantages of these solid high-alloys with savings up to 50% in material costs.

In addition to low first cost, clad steel permits easy and economical field erection. When you're thinking of new tanks and pressure vessels, *qualified* equipment builders can help you take advantage of the versatility of Lukens Clad Steels. Working with your engineers and consultants from the start, they tailor equipment to your exact needs. We offer the widest range of clad steels available and work closely with fabricators to help select the type most suited to your processing needs. If you would like further information, ask one of your builders or write Manager, Marketing Service, Lukens Steel Company, 752 Lukens Building, Coatesville, Pennsylvania.

**LUKENS CLAD STEELS**

**STAINLESS-CLAD · NICKEL-CLAD · INCONEL-CLAD · MONEL-CLAD**

PRODUCER OF THE WIDEST RANGE OF TYPES AND SIZES OF CLAD STEEL PLATES AND HEADS AVAILABLE



For more data on advertised products, use Readers' Service Cards, last page.

# HERE'S WHAT TO LOOK FOR IN REFRACTORY CASTABLES... *and WALSH has them all...*

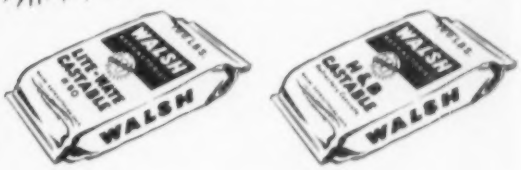
(thanks to better research and ceramic engineering)

Walsh Lite-Wate Castable No. 50 demonstrates remarkable trowelling workability

- **Uniform grain sizing assuring homogeneous structure for greater strength... better bond . . . throughout complete temperature range.**
- **Maximum resistance to abrasion.**
- **Ease of installation—whether by casting, trowelling or air gun placement.**
- **Highest modulus of rupture without sacrificing low "K" factor . . . wanted feature in light weight castables.**

These and many other advantages add up to performance characteristics that make Walsh Castables an investment in greater production... lower cost.

## THEY'RE HOMOGENIZED




**Lite-Wate Castable No. 50** . . . weight, dry, in place, 50 lbs. per cu. ft.

**Lite-Wate Castable No. 70** . . . weight, dry, in place, 70 lbs. per cu. ft.

**H & B Castable** . . . weight, dry, in place, 130 lbs. per cu. ft.

**Super Castable No. 32** . . . weight, dry, in place, 125-130 lbs. per cu. ft.

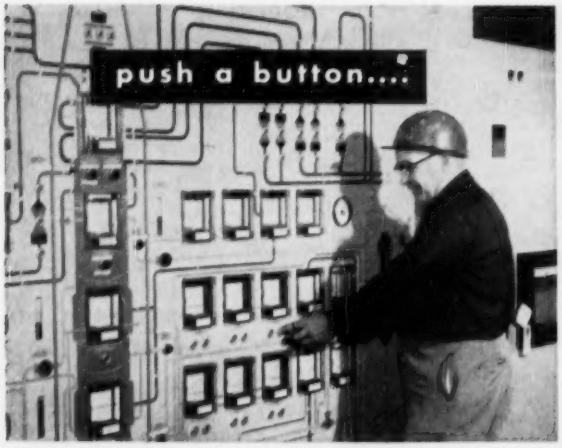
There's a light weight insulating or high temperature service type to meet your exact need. Get the whole time, labor and money-saving story from your nearest Walsh distributor or write us direct for complete data, temperature limits and prices.

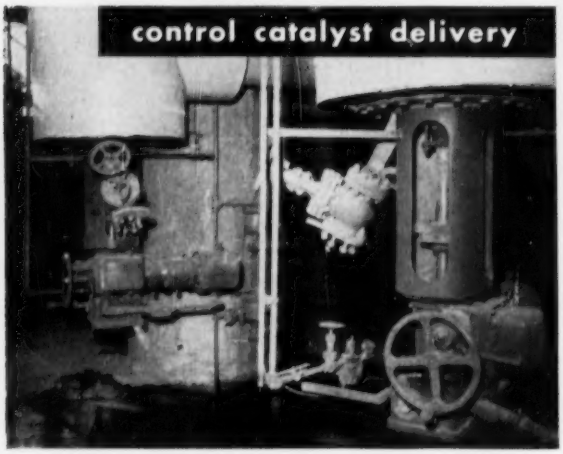
WALSH REFRACTORIES CORPORATION — America's Best Clays

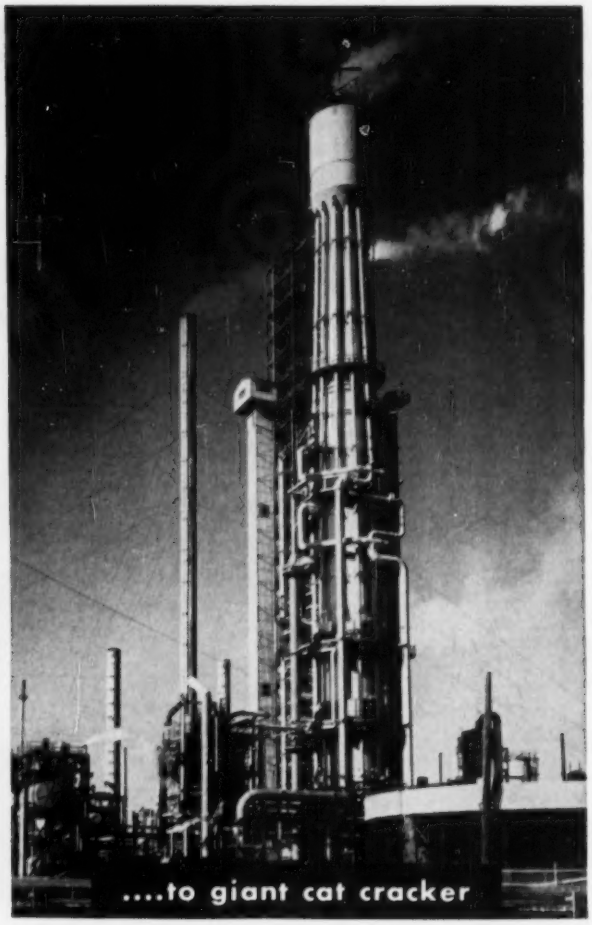
## WALSH REFRACTORIES CORPORATION

101 FERRY STREET • ST. LOUIS 7, MISSOURI

FOR OVER 60 YEARS MANUFACTURERS OF HIGH GRADE REFRACTORIES




# Limitorque® Valve Controls Maintain Constant Catalyst Flow in Sun Oil's New Houdriflow Unit at Marcus Hook

To process more than 50,000 gallons of hot oil, 700 tons of cracking catalyst is delivered per hour to the top of this 350 ft. reactor. Limitorque valve operators open and close specially designed mixer valves, maintaining uniform flow of the air-blown catalyst through 12 pneumatic lift pipes. The Limitorque units are actuated by remote, push-button controls at a central control room panel.

Accurate regulation of catalyst flow is vital to the catalytic cracking process. Limitorque valve controllers are handling the job efficiently and effortlessly.

Limitorque motor-operated valve controllers may be actuated either remotely or manually, to open and close all types of valves. They are readily adapted to microwave control. Wherever valve operation is important . . . look to Limitorque.

Send for illustrated 30-page catalog, L-550, describing Limitorque automatic valve controllers and components.

**PHILADELPHIA GEAR WORKS, INC.**

ERIE AVE. & G ST., PHILADELPHIA 34, PA.
NEW YORK • PITTSBURGH • CHICAGO • HOUSTON • LYNCHBURG, VA.
BALTIMORE • CLEVELAND
LimiTorque Corporation—Philadelphia

Industrial Gears & Speed Reducers

LimiTorque Valve Controls

Established 1892

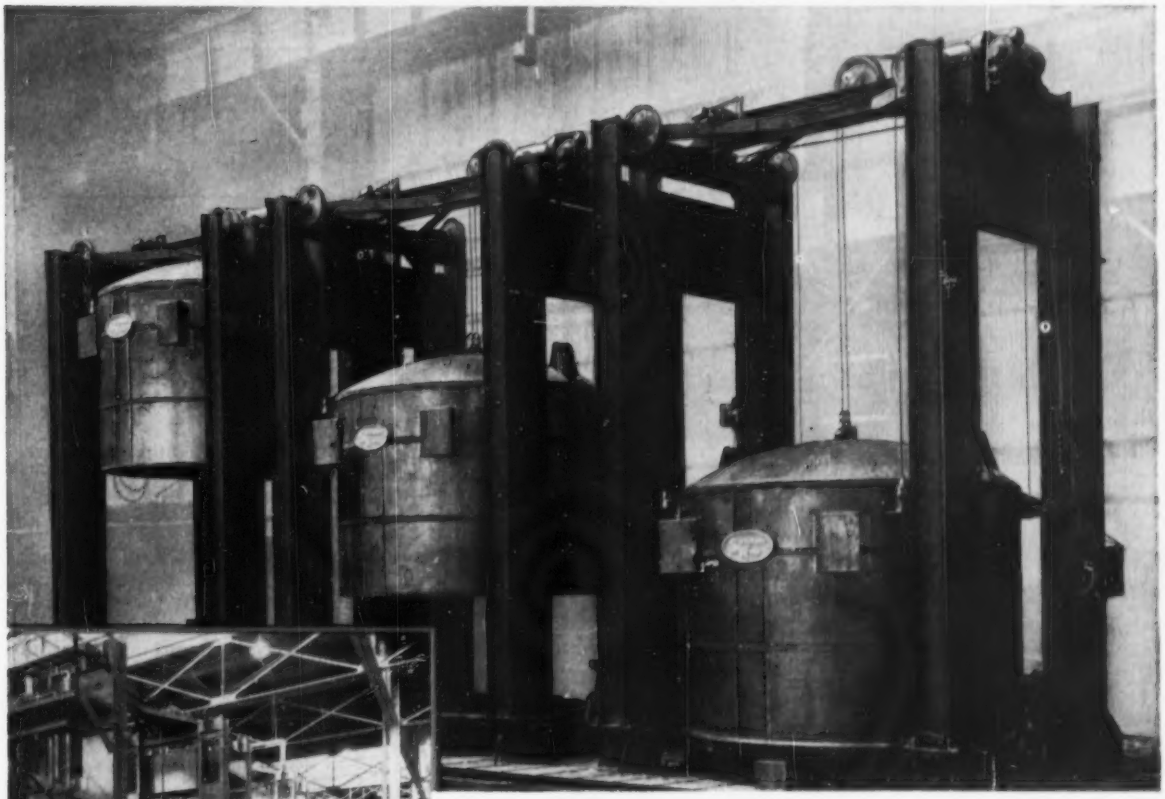


For more data on advertised products, use Readers' Service Cards, last page.

*Designed, engineered and built by Struthers Wells...*

# SPECIAL PROCESSING EQUIPMENT

*meets all code specifications and your exact requirements*



These shop and installation photos illustrate specially designed and engineered dryers for drying electrical cable under vacuum, with steam heat. Each is 8' in diameter x 6'6" high.

Struthers Wells—with unexcelled experience, research, engineering and modern equipped plants are constantly producing standard or specialized equipment such as that illustrated—for the process industries.

Call or write our nearest sales office or direct to our plant—for prompt attention and dependable handling of *your* process equipment requirements.

**STRUTHERS WELLS PRODUCTS**

**BOILER DIVISION**

BOILERS for Power and Heat . . . High and Low Pressure . . . Water Tube . . . Fire Tube . . . Package Units

**CHEMICAL PROCESSING DIVISION**

Crystallizers . . . Direct Fired Heaters . . . Evaporators . . . Heat Exchangers . . . Mixing and Blending Units . . . Quick Opening Doors . . . Special Carbon and Alloy Processing Vessels . . . Synthesis Converters

**FORGE DIVISION**

Crankshafts . . . Pressure Vessels . . . Hydraulic Cylinders . . . Shafting . . . Straightening and Back-up Rolls

**MACHINERY DIVISION**

MACHINERY for Sheet and Structural Metal Forming . . . Tangent Benders . . . Folding Machines . . . Roller Table and Tumble Die Bending Machines . . . Press Brakes . . . Punching and Notching Machines . . . Forming Dies

## STRUTHERS WELLS *Corporation*

Struthers Wells

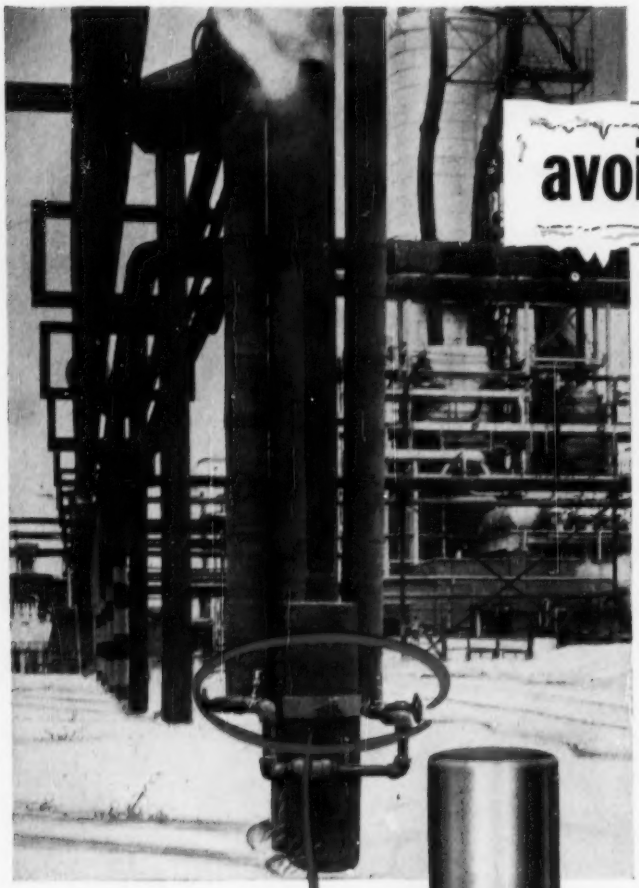
**TITUSVILLE, PA.**

**PLANTS AT TITUSVILLE, PA. AND WARREN, PA.**

***Offices in Principal Cities***



For more data on advertised products, use Readers' Service Cards, last page.



# avoid freeze-ups

## ...use Yarway impulse steam traps

Don't take chances with equipment freeze-ups and costly production delays. Put Yarway Impulse Steam Traps on all lines subject to freezing temperatures.

There's no danger of your lines freezing with Yarway traps. Condensate does not collect. The only moving part of the trap—a little valve—continually tests for condensate, discharges each bit as it forms.

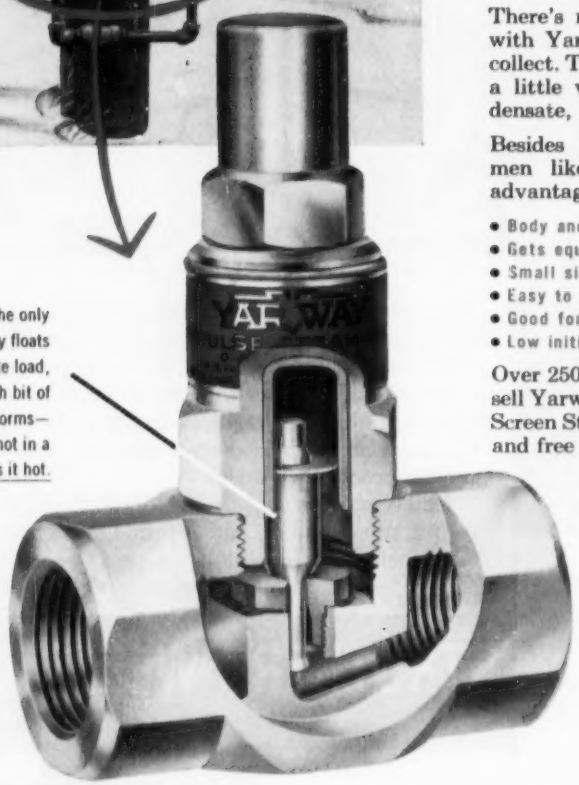
Besides this non-freezing feature, plant men like these other Yarway Impulse advantages:

- Body and all working parts are stainless steel
- Gets equipment hot in a hurry and keeps it hot
- Small size . . . light weight
- Easy to install . . . easy to service
- Good for all pressures
- Low initial cost

Over 250 Industrial Distributors stock and sell Yarway Impulse Steam Traps and Fine Screen Strainers. For name of one near you and free trap booklet, write . . .

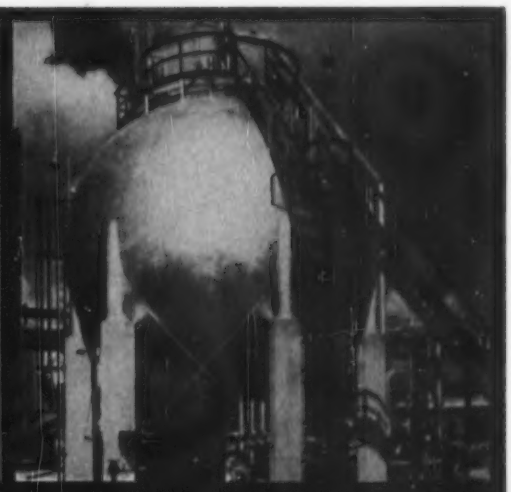
**YARNALL-WARING COMPANY**
128 Mermaid Ave.
Philadelphia 18, Pa.

This little valve, the only moving part, actually floats on the condensate load, discharges each bit of condensate as it forms—gets equipment hot in a hurry and keeps it hot.



**YARWAY® impulse® steam traps**

# WHY IS PETRECO-DESALTED CRUDE A SAFER REFINERY CHARGE THAN A NON-DESALTED "LOW-SALT" CRUDE?



**Even "low-salt" crude causes trouble. The trend in desalting performance is increasingly toward maximum removal, minimum residual salt.**

*Petreco desalting provides removal percentages in the 98 to 100% range, with residual salt averaging 1.5 ptb, and less.*

**A "low-salt" crude often contains solids such as sand, silt, rust and other plugging or abrasive materials to such a degree that they are more troublesome than salt.***

*Petreco desalting effectively removes such solids and fines.*

**A refinery operation planned on a "low-salt" charge is greatly upset if it becomes necessary to charge a salty crude.**

*Petreco desalting insures smooth operations regardless of the salt and solids content of the crude charge. Petreco desalting has effectively desalted every crude charged to it.*

**Minute quantities of arsenic can be present in any crude, "low-salt" or otherwise, and severely impair catalysts.**

*Petreco desalting reduces arsenic, stops catalyst poisoning.*

**Regardless of salt content, "slugs" of water are sometimes picked up in the crude charge when tanks are switched. Such water-slugs play havoc with distillation equipment.**

*Petreco desalting eliminates the hazard of water "slugs."*

**The storage of crude oils in the refinery often results in the deposition of "tank bottoms." These bottoms displace storage capacity, and cause an expensive disposal problem.**

*With Petreco desalting in the refinery, tank bottoms can be metered into the crude charge and easily disposed of.*

*In one refinery, usually charging crude containing only 5 ptb, Petreco desalting showed a rapid pay out solely on the basis of solids removed.

## 6 REASONS WHY PETRECO DESALTING IS PREFERRED BY SO MANY LEADING REFINERS

1 Highest salt removal efficiency

2 Only all-electronic desalting process

3 Desalts all types of crude

4 All basic equipment is designed by Petreco and furnished by Petreco

5 Petreco guarantees results and operating costs

6 Petreco desalting service staff offers know-how and facilities unequalled in the desalting field

Be sure you get all the facts on the Petreco Electric Desalting Process!

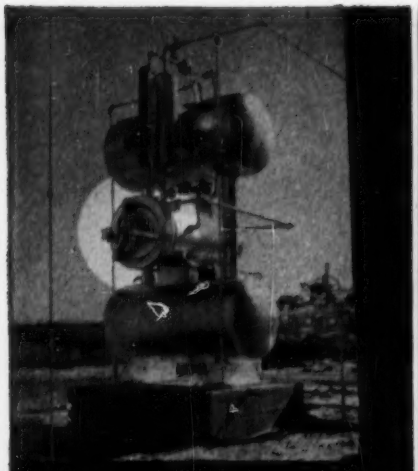
ELECTROFINING

# PETRECO

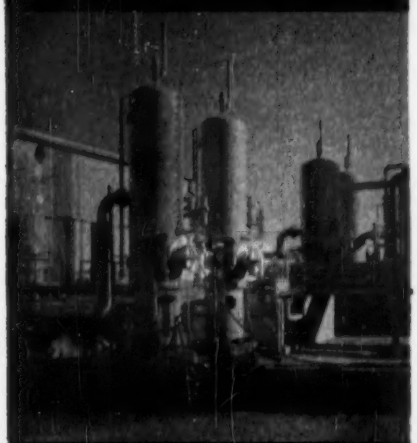
A DIVISION OF PETROLITE CORPORATION

**3202 SOUTH WAYSIDE DRIVE, HOUSTON 1, TEXAS • 1390 EAST BURNETT STREET, LONG BEACH 6, CALIFORNIA**

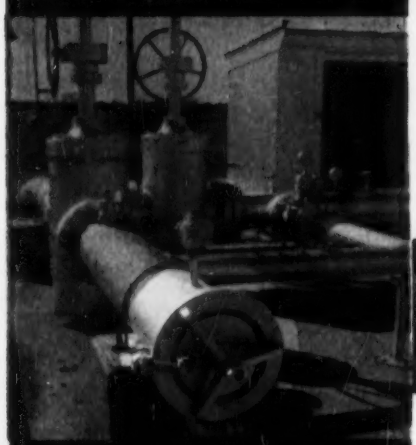
DS-9



It's no effort at all to reach the internals of this Peerless Gas Odorizer through the Sillers Flex-Ring Closure.



Sillers Flex Ring Closures are utilized on these large scrubbers at a Field Processing Plant in South Texas.



Here is a typical Sillers Flex Ring Closure installation on a Sillers Scraper trap on a products pipeline in Eastern Oklahoma.

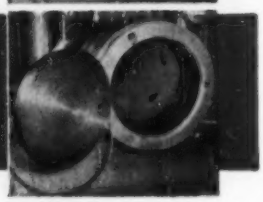
# *Faster than ever before...* SILLERS FLEX RING CLOSURES

**The Perfect Closure for Boilers, Evaporators, Heat Exchangers, Autoclaves, Filters, Strainers, Absorbers and all types of Pressure Vessels and Piping Systems.**

NEW, EASY SILLERS WAY

SILLERS FLEX RING CLOSURES give you many advantages and economies over the conventional flange type of closure, making the Sillers Closures about the most outstanding closure for the industry. LOW INITIAL COST . . . LESS TIME FOR OPENING AND CLOSING (JUST ONE BOLT) . . . TIGHTER SEALS AT HIGH PRESSURES . . . LESS WEIGHT . . . EASE OF HANDLING . . . and NO SEAL DESTRUCTION IN CASE OF FIRE, are just a few of the many advantages and features of the SILLERS FLEX RING CLOSURES. Sillers Closures are available in all standard sizes and can quickly be adapted for special applications.

*Send for Bulletin No. 3000*
*for Completely Illustrated Details*



## SILLERS ENGINEERING COMPANY

*Division of Peerless Manufacturing Co.*
BOX 13165 DALLAS, TEXAS

●

*Representatives in Principal Cities*

(1). Flex Ring Unit assembled as in service. (2). Spider released, gasket being removed. (3). After gasket is removed, plug is rotated to open. (4). Unit completely opened and in a fraction of time taken for conventional type closures.

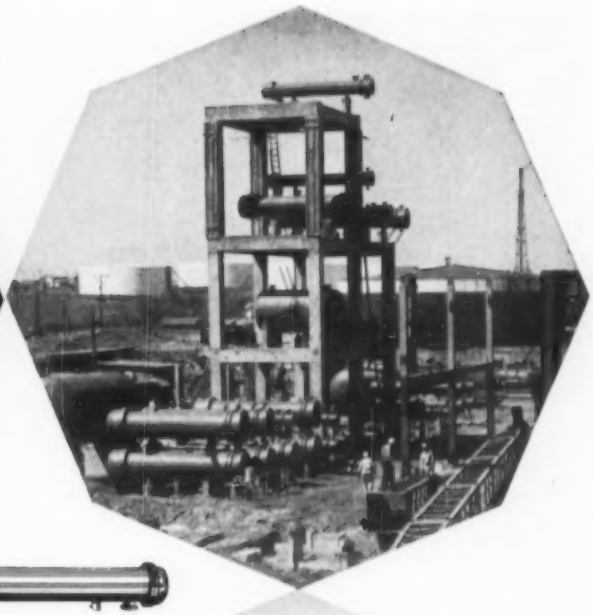


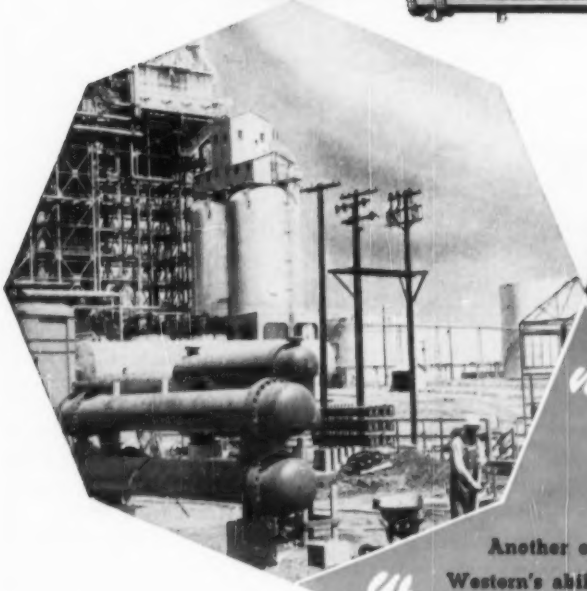
For more data on advertised products, use Readers' Service Cards, last page.

SUNRAY

NATURAL POWER

OILS





**Another example of Western's ability to deliver . . . on time!**

Shown above are Western heat exchangers installed in the Coking Unit superstructure at Sunray's Duncan, Oklahoma refinery. These photographs need no further explanation to men familiar with construction schedules.

Within a period of 8 weeks Western delivered all of the exchangers for The Lummus Company-built Coking Unit. . . The Refinery Engineering Company-built Platforming Unit. . . plus 19,000 square feet of Main Column Condensers for the Universal Oil Products Cat-Cracker.

For this one Sunray investment program — 46 heat exchangers from Western Supply Company aggregating a half million dollars worth of equipment.

WESTERN

HEAT EXCHANGERS

WESTERN SUPPLY COMPANY

P. O. BOX 1888 • TULSA, OKLAHOMA

HUDSON-RUSH COMPANY—753 Gladstone Blvd., Shreveport, La.
130 Casa Linda Plaza, Dallas 18, Texas

PROCESS INSTRUMENTS & EQUIP. CO. - North Bldg., Charleston, W.Va.



For more data on advertised products, use Readers' Service Cards, last page.

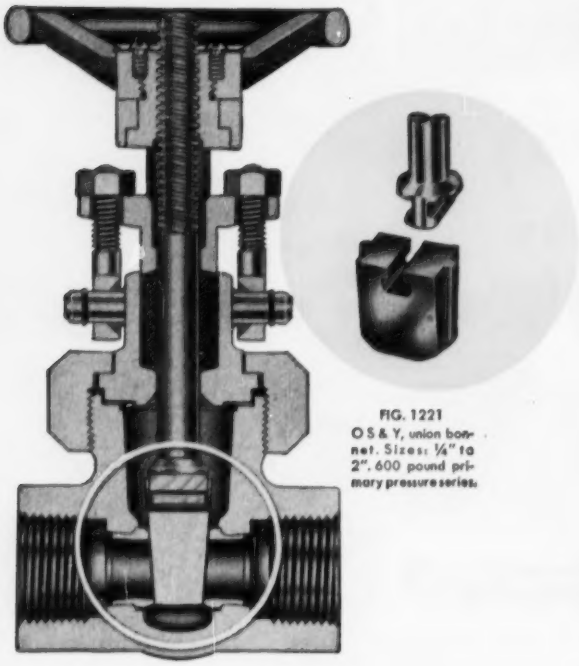


FIG. 1221
O S & Y, union bonnet. Sizes: ¼" to 2". 600 pound primary pressure series.

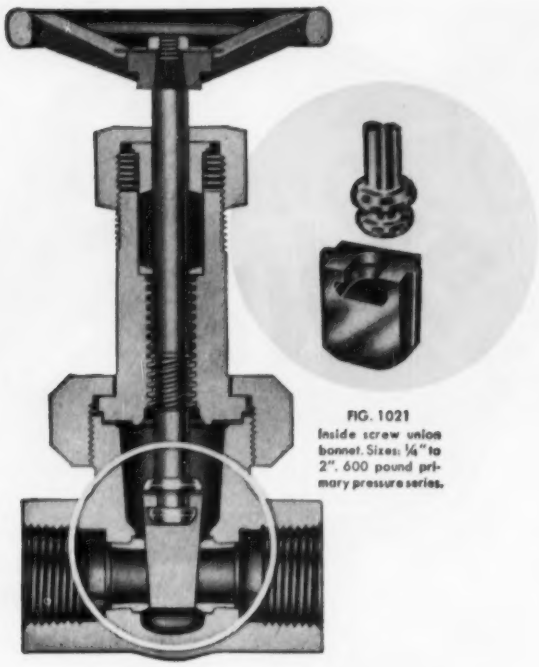


FIG. 1021
Inside screw union bonnet. Sizes: ¼" to 2". 600 pound primary pressure series.

# New design makes OIC forged steel gate valves the most modern line . . .

**NEW: stronger stem-to-wedge connection.** Improved, modern design increases pull-out strength to many times the theoretical requirement. This design distributes the pull-out load more efficiently throughout the wedge structure to meet the most stringent specifications of valve buyers in all fields.

**NEW: wedges wear longer.** Wedges are made of 13% chrome stainless steel for corrosion resistance. They are duracased to at least 1000 Brinell Hardness to prevent galling and excessive wear caused by frequent closures upon foreign particles in the flow.

**NEW: union bonnet design is more efficient.** Body-to-bonnet joint of the male-female type provides a recess for the gasket. It is contained more securely, reducing the possibility of leakage or a blown gasket.

**OTHER OUTSTANDING FEATURES**

Stem threads of all OIC inside screw, forged steel valves are always contained inside the bonnet. They can't possibly load up with corrosive matter which might be in the flow. This keeps the threads clean and free running, and contributes to longer stem wear.

Modern OIC Seal-Ever packing is a special composition which eliminates electrolytic action between the stem and the packing. This prevents stem corrosion in the packing area and helps maintain a leakproof seal.

Back-seating feature provides means of repacking valves while in service.

OS & Y valve gland "I" bolts are retained on trunnions by modern, more efficient, stainless steel snap rings.

Shoulder-type seat rings are expanded into the body under heavy pressure. They are accurately machined to mate tightly with the wedge for a positive seal.

Order modern OIC Forged Steel Valves from your nearby OIC Distributor. Write and request Folder No. 195.

OIC Forged Steel Valves are also available in globes, angles and checks in a variety of trims for any service.

**THE OHIO INJECTOR COMPANY • WADSWORTH, OHIO**

OIC FOUNDED 1893 VALVES

**FORGED & CAST STEEL, LUBRICATED PLUG, BRONZE & IRON**

ARTISTRY
IN STEEL···
stainless
alloy
clad
carbon
oil refining and chemical
plant equipment—
fractionating towers,
pressure vessels—
plate work—
special machinery—
heavy industrial equipment—
stainless steel
Skill with the torch, or any of a hundred different tools of the trade—in steel fabrications, massive or small—is fairly obvious in the quality of the finished product. The extra touch of Sun Ship's professional skill—acquired through years of countless difficult jobs—adds artistry ...which is evident in product performances and dependability beyond the demands of industry.

**Sun**

**SHIPBUILDING & DRY DOCK COMPANY**

SINCE 1916

ON THE DELAWARE • CHESTER, PA.

25 BROADWAY • NEW YORK CITY



For more data on advertised products, use Readers' Service Cards, last page.

NOW... greater piping loads,
longer travels, with less headroom
The Grinnell Model R Constant-Support Pipe Hanger is available now in an *extended range* of sizes to provide completely overlapping coverage of loads from 47 lbs. to 32,267 lbs., and with travels up to 12 inches. New design modifications permit these hangers to be installed with a minimum of headroom, ranging from 29 inches (rod take-out) for the largest size — down to 10¾ inches for the smallest size.
The Model R provides constant support which is mathematically perfect for all positions of travel. This constancy of support is maintained throughout the full range of field adjustability. Needle bearings minimize friction.
Grinnell Constant-Supports are individually calibrated to support the exact load specified. All Model R Constant-Supports have a full 70 percentage points of field adjustability built into them. No less than 10% of this adjustability is allowed either side of calibration for plus or minus change in load. Field re-adjustments are easily made by turning a single load adjustment bolt.
Grinnell designs, manufactures, and distributes a complete line of pipe hangers and supports for every piping requirement. Grinnell maintains an experienced staff of engineers in the field — ready to assist you on the job with any piping problem.
GRINNELL

**AMERICA'S #1 SUPPLIER OF PIPE HANGERS AND SUPPORTS**

**Grinnell Company, Inc., Providence, Rhode Island • Coast-to-Coast Network of Branch Warehouses and Distributors**

pipe and tube fittings • welding fittings • engineered pipe hangers and supports • Thermolier unit heaters • valves
Grinnell-Saunders diaphragm valves • pipe • prefabricated piping • plumbing and heating specialties • water works supplies
industrial supplies • Grinnell automatic sprinkler fire protection systems • Amco air conditioning systems

# The "Precious Plus" that didn't appear on the Blueprints

You *see* reactors, vessels, towers and piping — and they have the familiar look of any other Paraxylene and Udex plant. But what you *don't see* — what blueprints cannot show — is the "Precious Plus" that earmarks this "a BMC project".

At the time BMC was awarded the design and construction contract, the client had *firm* commitments to ship paraxylene within a fixed time period . . . a time period that would require tight scheduling — even for *conventional* design and construction.

But there was nothing ordinary about *this* Paraxylene plant. It called for a unique crystallizing process — developed by BMC but never before used — that would require time-consuming creative engineering.

Working under almost prohibitive time pressures, a BMC Task Force — with the *Key Man* + in charge — tackled the job. There was no waste motion in engineering. Drafting geared itself to a back-breaking schedule. Equipment orders were placed early. Usual "bugs" were anticipated — and avoided.

The plant went "on-stream" ahead of the client's *fixed* schedule . . . and first shipments were on their way well in advance of the contract commitments. Cost? Substantially below the estimate despite the emphasis on speed.

You can't see it . . . you pay nothing for it . . . but the "Precious Plus" included in this project is a part of every BMC proposal. Many leading petroleum and petrochemical companies have found it a distinct advantage in getting better plants, faster and at a lower cost. How else explain the unusual growth BMC is enjoying?

*The Udex and Paraxylene Plants described here were designed and constructed for Sinclair Refining Company, Marcus Hook, Pa.*

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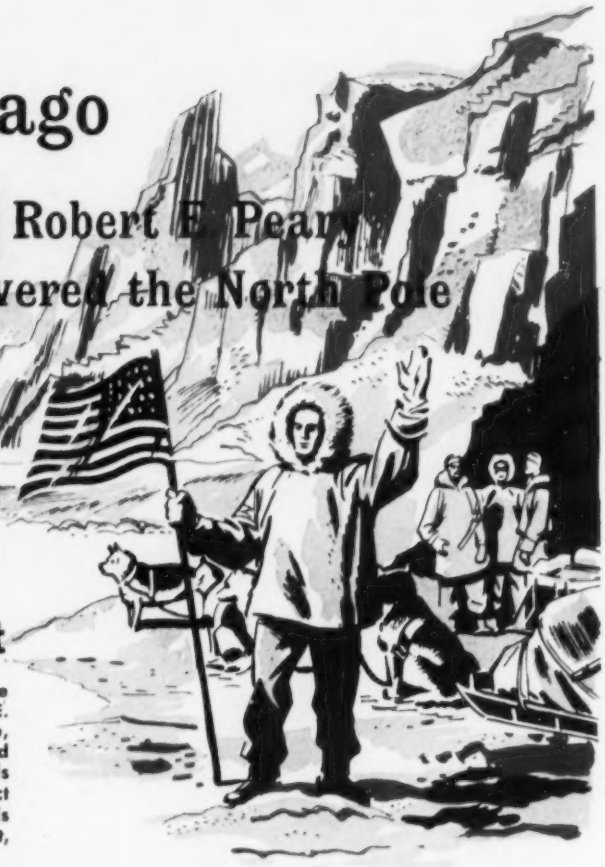

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## The Mail Box . . .

### Asks Design Questions

To The Editor:

In Daniel A. Donohue's original article "Heat Transfer and Pressure Drop in Heat Exchangers" (Ind. Eng. Chem., 41, 2499-2511, 1949) and in his current series appearing in PETROLEUM REFINER, an equation for unbored shells is given as

$$N_{Nu} = 0.22\ (N_{Re})^{.6}\ (N_{Pr})^{1/3}\phi$$

For bored shells, your constant is 0.25. This equation was recommended for the conventional split-ring design. I should like to know whether this includes the effect of by-pass strips or not.

In fixed tube sheet designs (as well as U-tube), the bundle penetration, as you are no doubt aware, is very much higher. Could you recommend "C" values for these designs? I believe that such information could be added to your footnotes on Figure 22 and Figure 23 of your nomograms in the October issue of PETROLEUM REFINER.

Davis Engineering Corporation
Abe Devore
Chief Rating Engineer

Elizabeth, N. J.

### Reply by Donohue

The equation quoted by Mr. Devore does not refer to exchangers with sealing strips. Up to the present time no experimental data have been published on shell-and-tube exchangers having sealing strips located between tube bundle and shell. I ran a few pressure-drop tests with water flowing through the shell on units containing sealing strips; the increase in pressure drop over a similar unit without sealing strips was slight. Although these strips are sometimes used there is no knowledge as to how much, if any, they improve the heat-transfer rate.

Mr. Devore's second query sounds like what the lawyers call "a leading question," and to its implied conclusion we take exception. The equation cited correlates the experimental data for all industrial units, many of which were either packed floating head or fixed tubesheet construction. In many units the OTL was ⅜ inch or less smaller than the inside diameter of the shell. However, although the clearance between OTL and shell I.D. varied, values of C did not vary correspondingly.

In the 1949 article cited by Mr. Devore the amount of flow which will penetrate a tube bundle was pointed out as being the key to shell-and-tube exchanger design, and the percentage of such penetration was noted to vary from 25-90 percent for the units which had been tested. It was assumed that for complete flow penetration in turbulent flow C in Equation (27) of the 1949 article would be 0.33. Since that time the efforts of some investigators have been directed to obtaining full flow penetration into the tube bundle. It would appear from the partial data reported that under certain special circumstances this may be attained.

We know so far that C is 0.22 for the average exchanger. When higher values of C are claimed by any manufacturer the burden of proof rests upon him to demonstrate by test that he has worked out an


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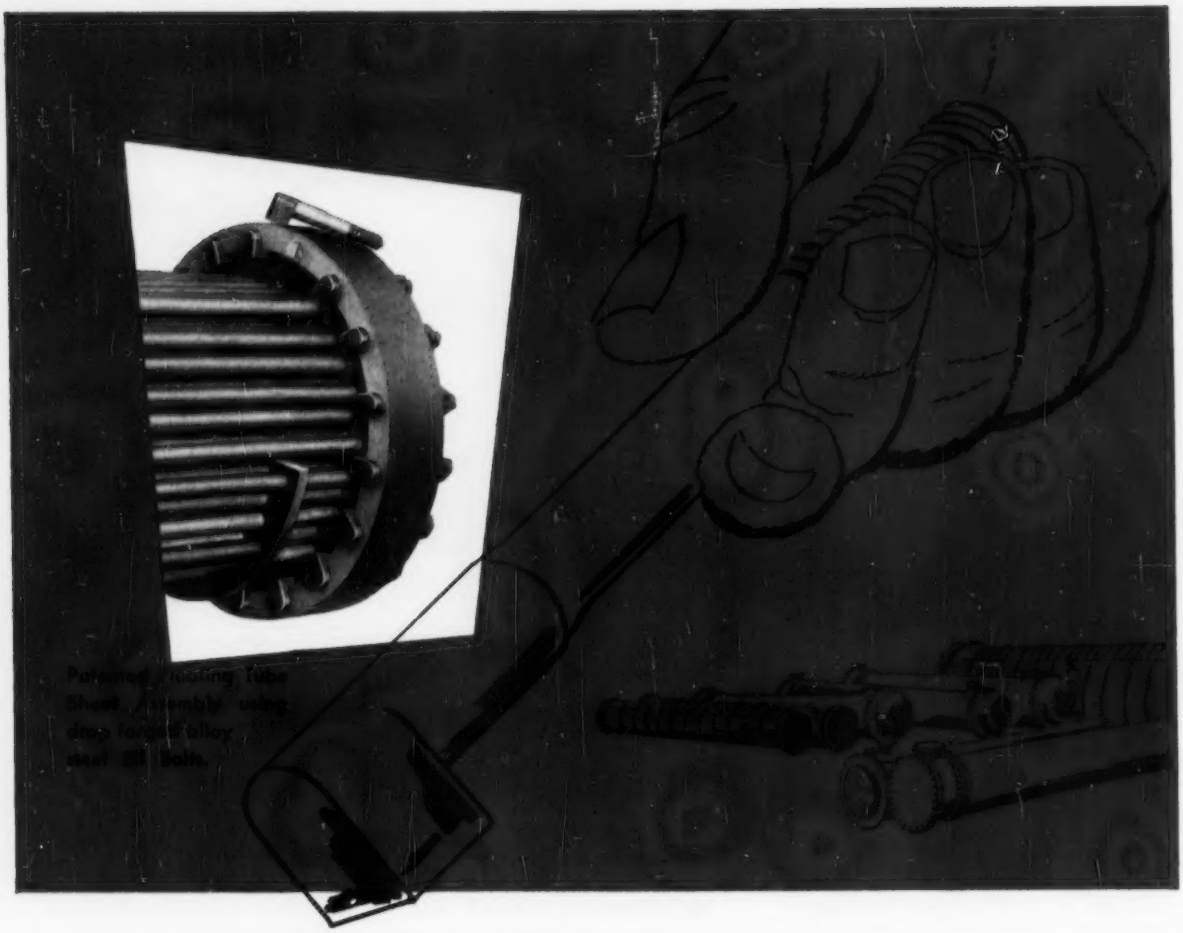

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## HEAT TRANSFER EQUIPMENT

improved design which produces higher values.

## Another Design Query

To The Editor:

Daniel A. Donohue's (article on Heat Exchanger Design, PETROLEUM REFINER, August, 1955) discussion of location of baffle opening interests me. This is a frequent problem. My company uses baffle openings to induce side to side flow for dirty fluids, and for vaporizing and condensing fluids. For all other applications we use baffles to induce up and down flow. Why is it not possible to standardize on side to side flow for all heat exchangers? Or is there an inherent thermal disadvantage in side to side flow. (This assumes channel cover nozzles at top and bottom.)

J. R. Conrad

Montreal, P. Q.

### Reply by Author

The practices described by Mr. Conrad are customary among manufacturers of heat exchangers. With fouling fluids square pitch and vertical baffle cuts are used as mentioned on Page 99 of this article. In condensers the baffle cuts must be vertical to enable condensate to drain from the shell. A vaporizer also requires vertical baffle cuts in order to permit the vapor generated to flow freely from the shell; baffles with horizontal cuts would pocket this vapor.

Referring to Table 4 of this article we find that with square pitch it makes no difference whether flow is vertical or horizontal; for both cases the flow area and the number of constrictions are the same. However, with triangular tube pitch flow may either be vertical (into the 60° angle) or horizontal (into the 120° angle); flow areas and constrictions for each case are different. In order to illustrate this difference the baffling used in Figure 3 will be rotated 90° to produce the modifications shown in Figure 38. The area for flow through the segmental cutout is calculated as follows:

(See Next Page)

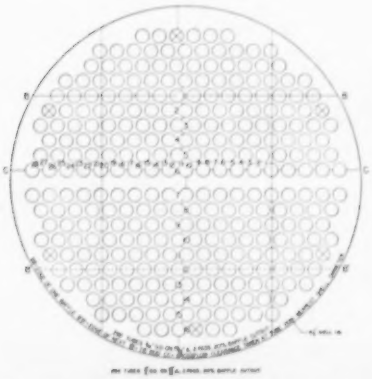

**FIGURE 38—Cross section of 20-inch unit. BB, edge of one baffle; B'B', edge of next baffle; CC, crossflow clearance taken at tube row nearest shell diameter; crossed circle, tierod. Author modified Figure 3 (PR, Aug., 1955, p. 94) by rotating the baffling 90°.**

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unions
give a 3 to 1
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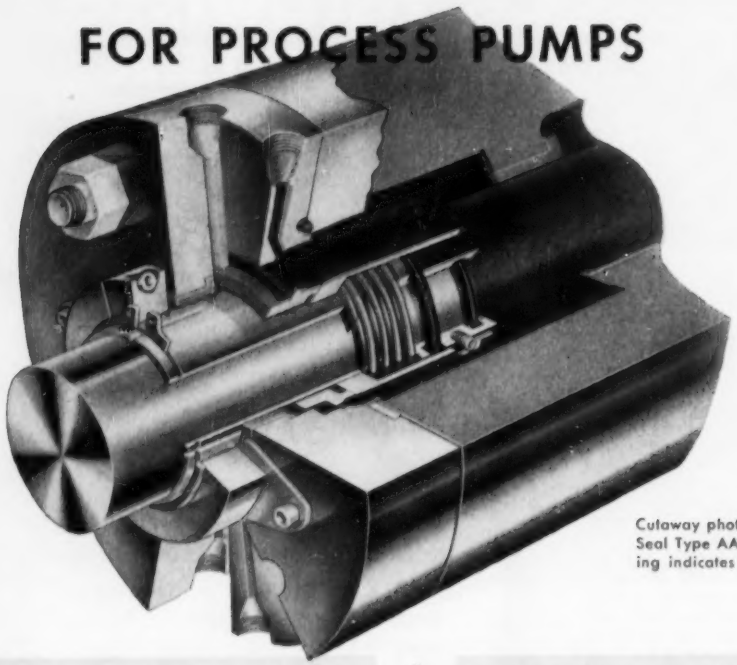
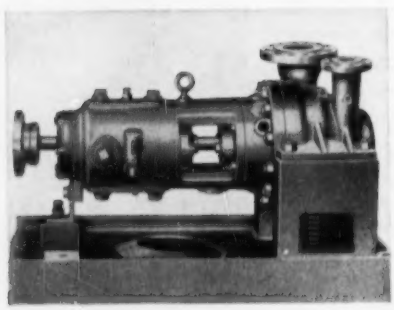


Cutaway photo of Garlock Unitary Seal Type AA51B-23. Yellow shading indicates liquid being sealed.

- One Piece Assembly
- Quick, easy installation
- Pre-set at factory
- Maintenance-free life



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## The Mail Box . . .

h/I.D. = 4.9375/19.25 = 0.256
Area of segmental cutout =
0.1588 $(19.25)^2$ = 58.9 sq. in.
Area of tubes = 0.4418
sq. in./tube × 53 tubes = 23.4 sq. in.
35.4 sq. in. =
0.247 sq. ft.

Crossflow area is taken at the vertical diameter.
Crossflow clearance =

$$\left(\text{number of diagonal tube spaces} \times \frac{\text{clearance}}{\text{diagonal}}\right) + S + \text{clearance between bundle and shell}$$

$$= \left(18 \times \frac{3}{16}\right) + \frac{5}{8}$$

+ 2.509 = 6.509 inches.

With a baffle spacing of 4½ inches the crossflow area = 29.25 sq. in. = 0.203 sq. ft.
$G'_c$ = 73.8 lb./(sec.) (sq. ft.)
$G'_b$ = 60.9 lb./(sec.) (sq. ft.)
The number of tube rows crossed is 28 from Figure 38.
The number of baffles is 38 and the number of crossflow paths is 39.
From Figure 27 $\Delta p'_b$ the pressure drop per baffle, is 0.019 psi.
From Figure 31 $\Delta' p_e \times$ s.g. = 0.005 46 and $\Delta p'_c$ = 0.007 39.
$\Delta p'_c$ = 0.007 39 × 28 × 39 = 8.05
$\Delta p'_b$ = 0.019 × 38 = 0.72
$\Delta p'_e$ = 8.77 psi
When 20 percent is added as a safety factor this value becomes 10.5 psi.
$G'_e$ = 67 and from Figure 23 $h_o$ = 169

Here is a case where baffles having the same size cutout and spacing are used first with the cutouts located at top and bottom to produce vertical flow, and then with the cutouts located at each side to produce horizontal flow. For an equal pressure drop in each case, the shell-side coefficient of heat transfer is 9 percent higher in vertical flow than in horizontal flow.

Channel partition plates are always placed in a horizontal position, as shown here, to allow the channel nozzles to be located vertically at the middle of the unit.

It is possible to rotate the tube spacing 90° and have horizontal flow into the 60° angle of the diamond. This arrangement would open the lane between tube passes to fluid flow; whether this is desirable or undesirable is something to be demonstrated by experiment. In any event, since most of the experimental exchangers have been arranged as shown in Figure 3 with vertical flow, it seems desirable to adhere to this arrangement until more experimental data become available for other arrangements.

### OK's Nomographs

To The Editor:

You are to be commended on your fine article and nomographs presented in the current issue of PR. More articles like this would enhance the value of your magazine to me.

Charles R. McNeese
Atlantic Refining Company
Dallas, Texas


Safe and Sure Packing for
HOT OIL CHARGE PUMPS
...ends packing blowouts and hot oil flashes

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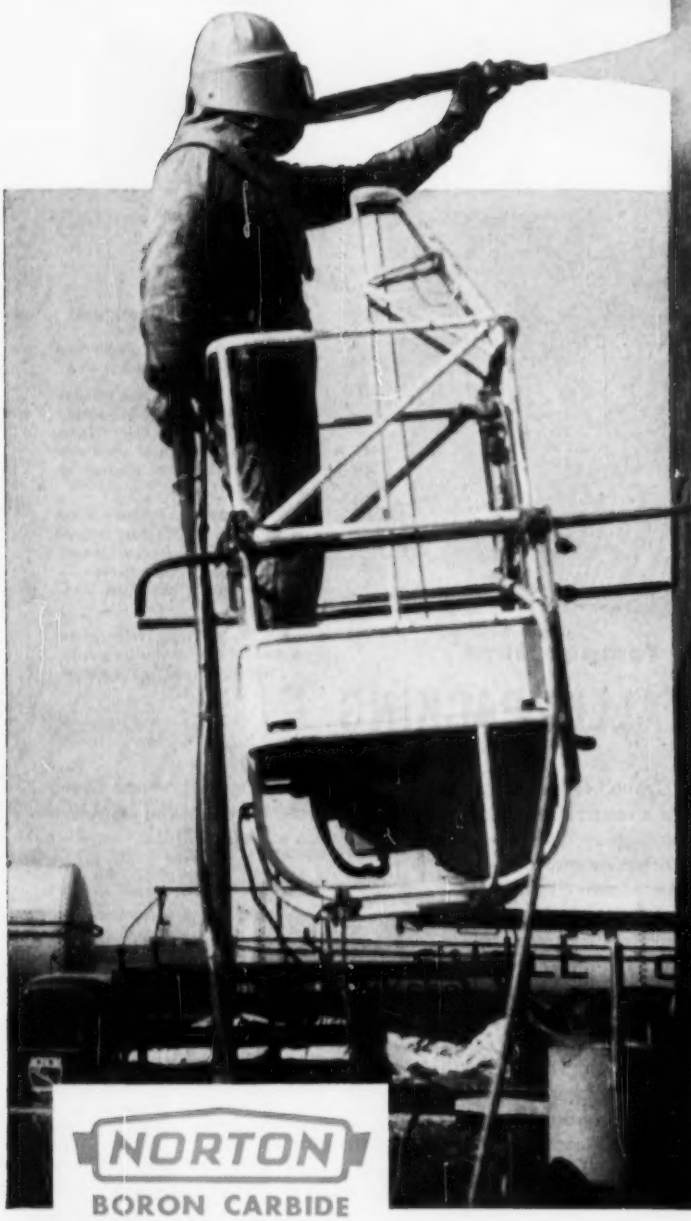

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# A Quick Look at the Industry THIS MONTH

Petroleum REFINER
January, 1956

**Who said "13" is unlucky?** '55 oil products demand jumped seven percent over '54—the 13th time in a row that demand increased over the previous year.

**During "unlucky" '55,** U. S. demand for oil products passed the 8-million barrels-daily mark for the first time in history. Oil supply rose to 8,722,000 barrels-daily—a daily increase of 643,000 barrels over '54.

**Predictions for '56:** Oil demand will taper off to four percent increase over '55. Gasoline demand will increase four-and-a-half percent. Spending for new plants and equipment will continue to set records in first quarter of '56—and perhaps on ihto the Summer. Watch out for the unpredictable factor—consumer spending. It will have important bearing on industry expansion.

—•—

**Following oil's pattern,** synthetic and natural rubber broke all records in sales and production during '55. Business position will remain competitive in '56, although synthetic producers still have advantage in capital investment and rate of production.

**Most significant '55 developments:** (1) Private industry's purchase and expansion of government-controlled synthetic rubber plants. (2) Discovery of a synthetic rubber which closely approaches physical properties of natural rubber. The new product has many advantages of natural rubber for truck tires which the synthetics couldn't duplicate before. Firestone is operating a pilot plant at its Akron site and Goodrich-Gulf has one under construction.

—•—

**Industry has its hands full** trying to keep up with jet-propelled growth in demand for polyethylene products. 350 million pounds were consumed in '55. Expected demand in '60: 630 million pounds.

**Paper and plastics industries** have been bitter rivals in the packaging market. Not so for the future. They will soon work together making food containers out of plastic-impregnated paper. Look for vinyl plastic and polyethylene to do the big job.

**Use of reinforced plastics as structural materials** is the coming thing. Big advantage lies in plastic's freedom to achieve almost any shape—often in one piece. A high strength-to-weight ratio is now possible and added strength at vital points can be secured by building up reinforcing filaments. Look for rapid growth in demand for this material in '56.

—•—

**Discount talk that an asphalt shortage is coming.** Even if Congress passes the highway program, industry is geared to meet the demand. However, a pickup in research on asphalt paving mixes is expected. New approach will more nearly simulate actual field service behavior of pavements, thus eliminating the major deficiency in current test methods.

—•—

**A cooperative program on standardization of pumps** is on the way. Result: Decrease in maintenance costs. Savings to the chemical industry alone will be about $6.8 million annually. Savings in the refining, natural gasoline and petrochemical industry should exceed this figure.

—•—

**Labor trends in '56:** After years of friction, Oil, Chemical and Atomic Workers (CIO) and International Chemical Workers (*previously* AFL) will start holding hands. May merge in late '56 or early '57. Result: All-out membership drive in the chemical industry. Also, increased bargaining power with management?

## A Quick Look at the Industry (continued)

**Are diesel locomotives on the way out?** Probably not, but Union Pacific's recent order for 15 more gas turbine-electric locomotives means that diesels will get a good run for the money. Union already has 25 of the gas turbine jobs in operation, the first one dating back to '52. They burn low cost bunker C fuel oil and will be a factor in diesel consumption for years to come.

—•—

**Despite rapid advance of atomic energy** into the power field, there is little immediate chance that it will be used in cars. Reason: Shielding is too heavy and disposal of radioactive waste is limiting. Even for stationary structures, disposal of these wastes will present serious limitations.

—•—

**Air pollution control can pay for itself.** Pittsburgh's solution of its air pollution problems has resulted in an annual saving on laundry, house maintenance and dry cleaning bills of $25 million a year.

—•—

**Management trends:** More firms are picking management people from their own employes. In a recent survey, 54 percent of the companies reported use of management development programs. More than 80 percent of the programs have been in effect ten years or less.

—•—

**Oil issues are in for hot and heavy debate** during second session of 84th Congress. Status of most controversial topics:

**Harris Bill**—may have an amendment tacked on requiring its return to the House. Anti-Harris leaders will give amendment full support in hopes of lessening bill's chances for passage this session. Bill is expected to pass in the Senate—if and when it gets there.

**Depletion**—political leaders state publicly that in spite of early attacks on depletion allowance, there will be no cuts this session.
**Imports**—more import-cut bills will be introduced, but with much less pressure behind them. Heated debates that arose in '55 will be more subdued.

—•—

**Growing trend toward entry into oil operations abroad** by U. S. companies is underscored by formation of Iricon Agency, Ltd., which represents active participation in the Iranian oil consortium, established last October, by nine U. S. oil companies—American Independent Oil Company, The Atlantic Refining Company, Hancock Oil Company, San Jacinto Petroleum Company, Signal Oil and Gas Company, The Standard Oil Company (Ohio), Tide Water Associated Oil Company, Richfield Oil Corporation, and Pacific Western Oil Corporation. Iricon, with an aggregate 5 percent interest, joins five U. S. and three European companies in the consortium.

—•—

**Wildcatting in the U. S.** yielded 93 new oil fields in November. Among those showing greatest initial promise were: Continental Oil's two new oilers in the Gulf of Mexico off the Louisiana coast, one in Jefferson Parish flowing 410 barrels of 38-gravity oil daily and the other flowing 453 barrels of 30-gravity in Plaquemines Parish; F. A. Callery, Inc.'s producer making 672 barrels of 42-gravity daily in St. Charles Parish, South Louisiana; Cabot Carbon's new find in Lea County, Southeast New Mexico, capable of 267 barrels of 40-gravity; Amerada Petroleum's 244-barrel 40-gravity discovery in McKenzie County, North Dakota; Frankfort Oil's Murray County, Oklahoma, well flowing 474 barrels; and Stanolind's addition in Andrews County, West Texas, good for 363 barrels of 41-gravity oil a day.

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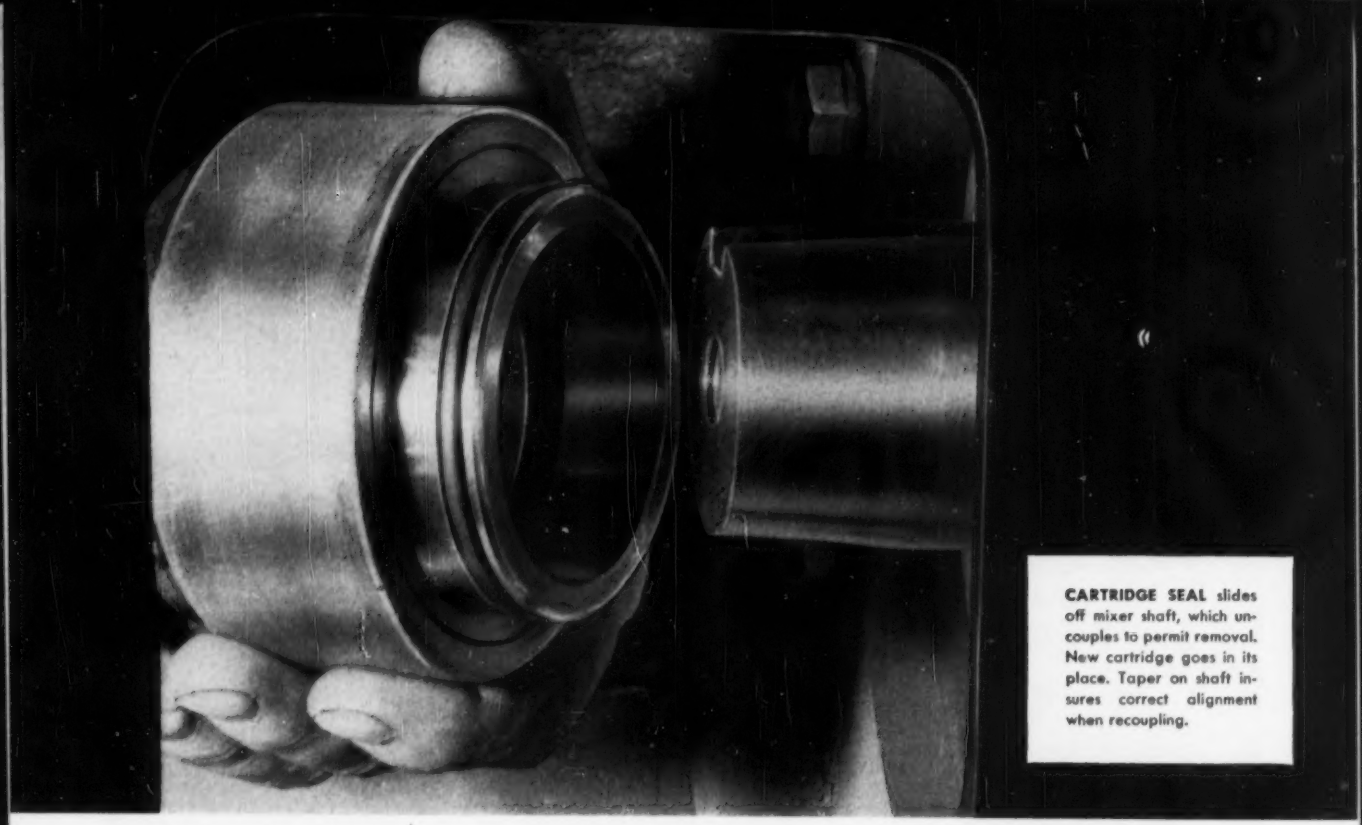

**CARTRIDGE SEAL** slides off mixer shaft, which uncouples to permit removal. New cartridge goes in its place. Taper on shaft insures correct alignment when recoupling.

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## *with this* cartridge-type *rotary seal*

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For here at last is a rotary mechanical seal—optional on new LIGHTNIN Side Entering Mixers—that stops leakage around the tank, ends stuffing-box repacking and adjusting for good.

And for the first time ever on big-tank mixers, you can replace this seal in a jiffy if you ever have to! No need to dismantle or remove the mixer from the tank. No need to drain the tank. No special skill required!

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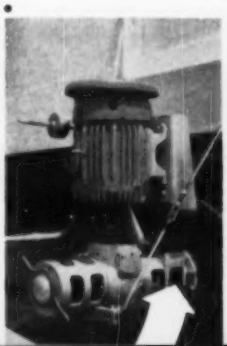

# The "Engineer Shortage"—A Pro and Con Treatment

INDUSTRY MANAGEMENT says there is a critical shortage of qualified scientists and engineers.

Educators, working technicians and technical groups say there is no need for a shortage—if there is one.

Who is right? Perhaps the answer lies in the definition of the word "shortage." The word is a relative one and to be specific in its use we must add "compared with what?"

Most of us will admit to a personal shortage of money, compared with what we would like to have. The relation of "want," "need," and "have" must be carefully considered in such comparisons. Is it possible that we have a shortage of engineers compared with what is wanted, not as compared with minimum need? Need, practicably, must compromise with what can be had.

**Here is how** the proponents of "shortage" define it:

... Russia is training engineers and scientists at a faster rate than we are. It is reported that last year the Soviet Union graduated more than twice as many engineers as the U. S.

... U. S. schools graduated 23,000 technical men in 1954-55 compared with industry's "want" of 42,000. The same problem will exist in 1955-56, perhaps with more graduates (26,000) to fill a greater industry "want."

... According to recent surveys of industry management some companies (half or less of those replying) feel that a shortage exists in the *type* of men they want.

... A number of companies, with the petroleum industry in the lead, have taken steps at the local high school level to check the disintegration of science and math teaching. Thus, it is hoped that more and better technical and scientific personnel will be produced in the future. Similar assistance by way of grants and scholarships is being given to colleges and universities by industry. Some larger companies are even financing their own engineer-training programs.

On the other hand we are witnessing an effort to unionize engineers and scientists. Unionization is, in every sense, a concept that is utterly opposed to the normal and expected professional manner and attitude of individual creative ability appied in the most profitable manner.

Unionization, it is said, is accomplished in an atmosphere where basic conditions of communications, recognition of accomplishment, opportunity to progress, delegation of responsibility and authority, compensation and professional prestige are seriously impaired or lacking. Management should ever be alert in maintaining conditions that preclude this possibility.

**Now, let's see** how the other side uses the word "shortage":

... In this country we have always taken pride in free enterprise, respected economic success, and have paid the price to get what we wanted. Ours is a free economy guided by supply and demand.

If there is such a shortage of engineers, why haven't the demand indications such as pay offered and other compensations risen perhaps at a faster rate?

... Why do older professional men find it difficult or impossible to obtain professional employment? This fact has been established by a recent survey by the Engineering and Scientific Manpower Commission.

... Questions have been raised about the use of available men to the limit of their technical abilities. The physician's approach has been cited. He gives his talent and time to his patient, while others care for administrative detail and non-medical matters. Thus, the fullest use is made of his medical capabilities.

*Is every technical man's professional ability as carefully used?*

... An intermediate solution to the shortage of scientists is to make better use of the present supply of manpower. Management should realize the importance of the research audit—relating effort expended to return on research investment—to insure most effective use of trained personnel. Many companies could solve the shortage problem by sponsoring intensive training programs for project leaders and other technical people.

... **Why do many employers** follow arbitrary retirement plans—even though many active and competent professional employes' services are lost in the process?

Retirement plans, to some extent, are outmoded. They were initially devised to meet an acute depression situation in which younger people had trouble finding jobs. Now that there is full employment—in fact, a shortage of some types of workers—retirement policies are proving too inflexible.

The nation finds itself with a minimum population between ages 20 and 65, with increasing numbers aged 65 or over—and rapidly increasing numbers in the age groups under 20. This means, in effect, that the few must support the many without benefit of the services that those of retirement age are still capable of rendering. Scientists and engineers, of course, are included.

... Is there a critical shortage of graduate scientists and engineers? The head of an engineering school tells of a recent interviewer visit: "Thirteen ChE graduates were available. Three were A average men, the rest B and C average. The interviewer rejected all. The A men were unacceptable because of undesirable

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religious, nationality or physical characteristics. He wasn't interested in B or C students."

Then recently the Dean of a graduate school said the demand for science and engineering PhD's is becoming a fad in industry—to the extent that many are being hired at high salaries to fill jobs that could be handled by men with much less educational background.

**If industry has set** its standards this high, this may be why management cries "shortage"!—and educators reply, "Then why don't you hire our graduates?"

We all learn sooner or later that we must pay for what we get. We pay in many ways, money among them. In business and industry, you pay the market price, like it or not, if you get the goods. Is it a reluctance to pay in the market for what is wanted that brings the cry, "shortage?"

All of us know men with engineering and scientific training who left the field for other occupations. Has anyone surveyed this group and examined the reasons? If the cause was to seek greater individual opportunity or compensation, then the technical profession may not have been comptitive in offering opportunity and compensations.

## What Problems In 1956?

AS WE ENTER the beginning of a new year, let's take a look at what problems we're bringing with us and what solutions we made in the past year.

**Gas regulation:** At the beginning of 1955, one of industry's big stumbling blocks was the FPC ruling on natural gas regulation. It was hoped then that the Natural Gas Act would be amended to insure an adequate supply of gas. That problem is still with us and the chances for change in 1956 are probably no better than 50-50.

**Supply and demand:** This was a number one problem in early 1955, but the picture has brightened considerably. In fact we might say that our fears at that time were not borne out. With the general economy on a boom, oil demand was proportionately high. For the year 1956, we can relegate this problem to only a routine role.

But there will be the problem of keeping costs in line with present product prices. The situation was and still is a buyer's market. Our gasoline wars were not too bad in 1955 and we expect more of the same in 1956.

**Imports:** Oil imports were a serious problem to some during 1955 and not much happened to change the situation. It's definitely a problem that we'll be carrying with us in 1956. Voluntary restrictions on imports have really not satisfied independents; and government regulation is not wanted by the majors.

**Octane Race:** There's no stopping it, we admit. Refiners have done well in 1955 to tool up for the situation but some small refiners have been squeezed out of business entirely. We'll see the race continued in 1956. The problem will be to put out a higher quality product at the same price and still make a profit.

**Manpower shortage:** The supply of engineers worried many during 1955. The situation will probably be worse in 1956. The problem for 1956 will be to interest more high school students in science as a career and assure the supply of science teachers to make this inspiration possible.

These are all expedient problems. Here are the long range problems we answered to in 1955: Will automation dislocate labor seriously? Will atomic energy squeeze petroleum out of the fuels picture? Who's getting hurt by mergers? How will we be affected by the guaranteed annual wage? The year 1956 will provide further answers to these problems but we do not view them with any immediate alarm. In fact, we think some of them will prove to be no problem at all.

Despite our problems, 1956 should truly be a great year. The petroleum industry will find the answers to many of them and the others will fall in their proper place.

## Distillate Stocks Giving Ground

STOCKS OF DISTILLATE fuel oil are in fairly good position despite recent high refining operations. Colder weather and the larger number of oil burning furnaces in use boosted consumption of these heating oils to the point that drafts on distillate inventories have been considerably heavier than they were a year ago. This has occurred despite the fact that output of these oils from the first of November to December 9 averaged 118,500 barrels a day more than had been produced a year earlier.

On the later date, distillate oil stocks totaled 134½ million barrels, which showed they had been redured 17⅓ million barrels since the first of November. If cold weather prevails, inventories of distillate will be dropped to desirable levels by the end of the heating season. With the heating oil situation looking bright, the only apparent cause for concern is that current high refinery runs will result in accumulation of too much gasoline.

Record runs to refinery stills have resulted in large volumes of motor fuel. Inventories of gasoline hit 158⅓ million barrels on December 9, an increase of 6½ million barrels since the first of November. At that point, they were nearly 8 million barrels greater than they had been at the same time in 1954, although they were only 2 million barrels ahead at the beginning of November. During the same period of 1954, gasoline stocks grew by only one million barrels.

It would appear desirable if motor fuel inventory build-up during the next three months could be held closer to the year-before rates. They are already 8 million barrels above a year ago and this spread seems adequate.

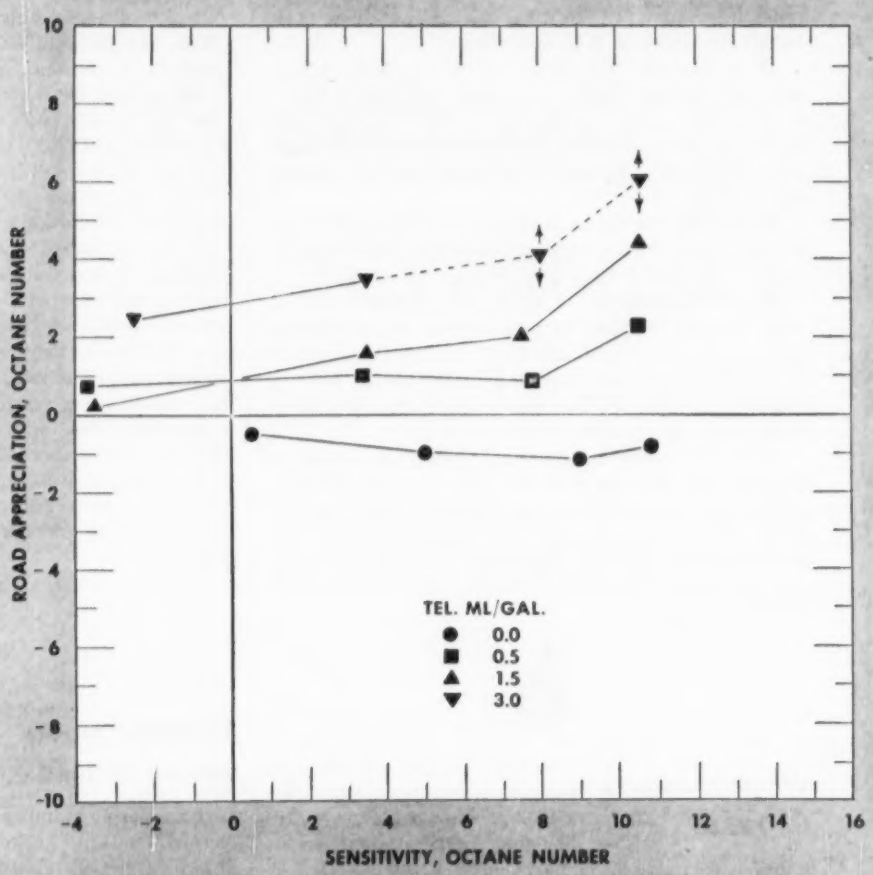


**Fig. 1.** Sensitivity versus appreciation. Note that the appreciation at any given sensitivity level increases with lead concentration.

# *Blending Hydrocarbons for* Maximum Octane Potentials

*By F. D. BUERSTETTA*
*Ethyl Corporation, Detroit, Mich.*

The manufacture of high-octane gasolines to meet today's and tomorrow's automotive demands is putting increasing pressure on the refiner. To meet these requirements, the available hydrocarbon components in the refinery must be blended to best advantage to give maximum performance on the road.

Each octane number at the 100-octane level may cost as much as 15 to 20 cents per barrel. Thus there is a marked incentive for insuring that every laboratory octane number, obtained at this great expense, provides corresponding antiknock performance in cars on the road.

### Hydrocarbon blends studied

As part of a continuing Ethyl Research program to establish the fundamentals of laboratory versus road antiknock quality, a study was recently conducted in which the behavior of blends of pure $C_7$ and $C_8$ hydrocarbons was examined.

Within this $C_7$-$C_8$ range, the four basic hydrocarbon types — olefins, paraffins, naphthenes and aromatics — were blended in varying proportions. Actually, a mixture of isooctane and *n*-heptane was used as the paraffin constituent to permit maintenance of a constant Research octane number while investigating the effects of tetraethyllead concentration and variations in hydrocarbon-type composition. Toluene, diisobutylene and methylcyclohexane were selected to represent the aromatics, olefins and naphthenes, respectively. Each of these hydrocar-


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**Send for your free copy** of a technical paper entitled "Octane Possibilities with $C_7$-$C_8$ Hydrocarbons" by F. D. Buerstetta and T. W. Warren. Address your request to Box 14, Ethyl Corporation, 100 Park Avenue, New York, N.Y.

bons was blended in concentrations of 20, 40 and 60 per cent by volume with the proper paraffin mixture, giving nominal Research octane levels of 92, 96 and 100 at each of four tetraethyllead concentrations—0.0, 0.5, 1.5 and 3.0 ml. per gallon.

Each blend was evaluated in single-cylinder laboratory test engines and was then rated in the 9 to 1 compression-ratio engine of a 1955 passenger car equipped with an automatic transmission. Road ratings were made by both the Modified Uniontown and Modified Borderline techniques.

### Road appreciation defined

Some of the test results are summarized in Table 1 in terms of road appreciation, which is the road antiknock rating of a fuel minus its Research octane number—or the bonus obtained in actual engine performance over the indicated laboratory knock rating.

The general analysis of data shown in Table 1 may permit a refiner to achieve better road performance than could be secured by using only Research octane number as a guide. It will be seen that aromatics should be maximized and olefins minimized as much as possible when making top-octane fuels. Since most of today's catalytic reforming processes eliminate naphthenes through dehydrogenation to aromatics, consideration of them is somewhat academic, but nonetheless interesting.

Further evaluation of the large quantity of test data obtained from this project indicates a most interesting correlation between appreciation and the concentration of tetraethyllead. Figure 1 shows a plot of sensitivity versus appreciation with points representing the same tetraethyllead concentrations connected. It can be seen from Figure 1 that the appreciation at any given sensitivity level increases with lead concentration.

### Conclusions

The general conclusions which can be obtained from the study are as follows:

**1.** Best over-all antiknock performance can be obtained by blending a high proportion of aromatics with paraffins and adding the maximum amount of tetraethyllead.

**2.** Where low-speed knock resistance is critical, high aromatic content is necessary.

**3.** Where high-speed antiknock performance is critical, high aromatic content is less important, but maximum tetraethyllead concentration is still essential.

**Table 1.** Average change in road antiknock appreciation with addition of aromatics, olefins or naphthenes to paraffins in the $C_7$-$C_8$ range.

| Research Octane No. | Added Component | Modified Uniontown | Modified Borderline | |
|---|---|---|---|---|
| | | | Low Speed | High Speed |
| 92 | Aromatics | +0.6 | +1.1 | +0.6 |
| | Olefins | +0.3 | +1.1 | −2.0 |
| | Naphthenes | +0.6 | +2.0 | +3.8 |
| 96 | Aromatics | +0.9 | +1.7 | +0.6 |
| | Olefins | +1.6 | +1.1 | −3.3 |
| | Naphthenes | +2.4 | +4.2 | +2.7 |
| 100 | Aromatics | +0.8 | +1.5 | −0.7 |
| | Olefins | +0.5 | +0.0 | −5.7 |
| | Naphthenes | +3.4 | +3.7 | +1.7 |


# HOW Ethyl Research can help you

At today's high octane levels, the science of blending hydrocarbons has taken on more and more importance. As a service to the oil industry, Ethyl Research has launched a hydrocarbon blending program of its own to complement the intensive effort which the industry is devoting to this problem.

We are now testing many new blends in our laboratories and in high-compression engines on the road. Much of the data from these tests is being interpreted in terms of "road appreciation" to give refiners a better idea of the effectiveness of each blend. Write for a copy of "Octane Possibilities with $C_7$-$C_8$ Hydrocarbons"—another in the continuing series of reports from the Ethyl Corporation on fuel blending and other studies of vital interest to refiners today.

For further information, just call your Ethyl Representative. He'll be happy to arrange an appointment for you with one of our Technical Representatives.

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**Research Laboratories:**
1600 W. Eight Mile Road, Ferndale 20, Mich.
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## Report on British Petroleum Company's

# $560 MILLION EXPANSION

**What caused the big change in BP's refining activities since World War II? Here are the reasons:**

- **BP's decision to refine nearer the consumer market, rather than the source of production.**
- **The Abadan refinery shutdown in '51.**

SINCE THE END of World War II, the British Petroleum Company has spent well over $560 million on refinery expansion. This has involved the building of completely new refineries and the expansion of existing installations in seven countries.

The dedication of the new 70,000 barrel-a-day Kwinana refinery in western Australia in October of 1955 marked the completion of BP's main postwar refinery program. It is now possible to look back on this program and consider its most important aspects.

In the last ten years, the pattern of BP's refining activities has undergone a basic change. This has been due to two main factors:

- Acceptance of the policy adopted generally by the oil industry after the war of refining as near as possible to the consumer market, instead of near the source of production.
- Closedown in 1951 of Abadan refinery.

It was thought at first that the demand for oil products would slacken after the war, at least temporarily. But this was not the case. The demand grew rapidly, and to keep pace, production of crude oil and refining capacity had to be substantially increased.

In Europe and the U. K., refinery expansion programs in general were faced with considerable difficulties. Many plants had been destroyed during the war, and there was an acute shortage of materials. In the early months of expansion, improvisation became the keynote. Oil units were modified, prewar cracking plants were converted to distillation, and by skill and ingenuity, refinery throughputs were substantially increased.

BP made a considerable contribution to this expansion. In 1946, BP's total refining capacity in Europe was 36,000 barrels per day. Now, with the commissioning of Aden refinery, and of Kwinana refinery, the company has a world-wide capacity of 700,000 bpd.

**United Kingdom**—BP has three main refineries in the United Kingdom. Llandarcy refinery, South Wales, has a capacity of 70,000 bpd; Grangemouth refinery, Scotland, 50,000 bpd; and Kent refinery, Isle of Grain, 90-000 bpd. The company also has a small 3500 bpd refinery at Pumpherston, Scotland, for the refining of shale oil.

Llandarcy is the oldest major refinery in the company. It was opened in 1922 to deal partly with crude oil and partly with semi-refined oil shipped from Persia for re-distillation into white products.

Soon after the war, plans were put in hand for increasing Llandarcy's capacity, primarily by means of a new 40,000-bpd distillation unit. This unit was commissioned in 1949, and had the distinction of being the first major piece of new refinery equipment commissioned in the U.K. since the war.

In 1951, when Abadan closed, every effort was made to augment the refinery's throughput. The two thermal crackers of prewar days were converted into crude topping units, and the throughput was raised to more than 90,000 bpd. With the re-opening of Abadan refinery, however, in which BP now has a 40 percent interest, Llandarcy's rated capacity has been reduced to 70,000 bpd.

Other units installed at Llandarcy include a catalytic cracker, a Plat-

### What Companies Are Leading In Postwar Expansion?

On these pages is another in a series telling the story of Refining's fabulous growth since World War II. A continuing program . . . it has kept management, engineering and construction forces going full pace.

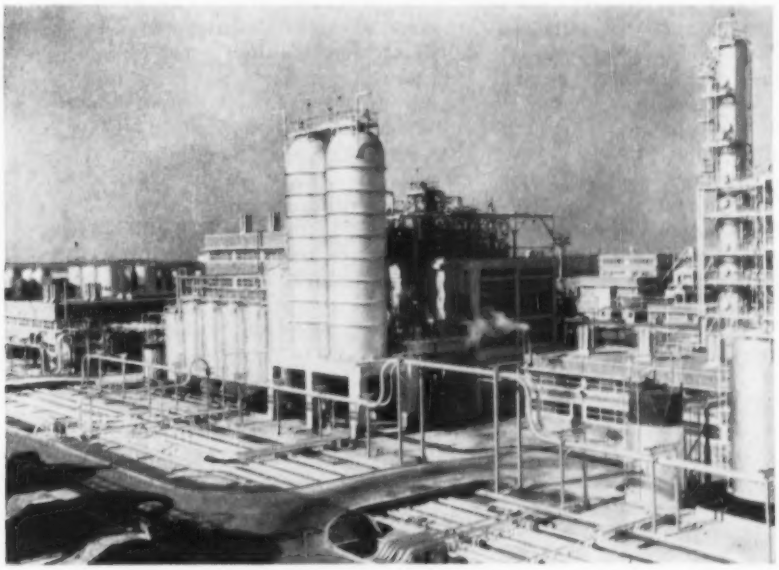
The Socony-Mobil story, announced for this issue, will appear later.

## After Dunkirk . . .

**Refinery in Dunkirk, France, after May, 1940, bombing. As photo shows, plant was nearly demolished. Then B.P. rebuilt . . .**

## As It Looks Today . . .

**MEK and Contact Filtration Unit in center with part of Furfural Extraction on right, and wax finishing unit in right background.**



former, and lubricating oil plant, including propane deasphalting, furfural extraction, M.E.K. dewaxing, and recrystallization and high temperature clay treatment units.

Grangemouth refinery, on the Firth of Forth, Scotland, was opened in 1924. As in the case of Llandarcy, two cracking units were installed in 1930 to produce an improved grade of gasoline.

A solvent extraction unit was also added to manufacture a premium-grade lamp oil and vaporizing oil.

During the war the refinery had to shut down because of the shortage of crude oil, and it did not recommence operations until 1946. Work on the Grangemouth expansion project started in 1949, and capacity was increased from 7500 bpd to 50,000 bpd by the installation of a new distillation unit and the conversion of thermal crackers to crude distillation units. A catalytic cracker has been installed, together with treatment units, and the expansion program was completed in 1954 with the commissioning of a catalytic polymerization unit, a Girbotol plant, and a sulfur production unit.

The refinery also provides feedstock for the manufacture of chemicals. In 1947, BP, in partnership with The Distillers Company, formed British Petroleum Chemicals Ltd., and a factory was built next to Grangemouth. Naphtha feedstock is supplied by pipe line from the refinery, and the factory is producing two alcohols, ethanol and isopropanol. Another plant, that of Forth Chemicals Ltd., in which BPC and Monsanto Chemicals Company are partners, has been built near the first for the manufacture of monomeric styrene.

Although Llandarcy and Grangemouth were well situated to supply markets in the north of England, Scotland and Ireland, the company lacked refining capacity in southern England. Accordingly, a site for an entirely new refinery was chosen on the Isle of Grain, Kent, and work started in 1950. Originally, the new refinery was to have a capacity of 50,000 bpd, but with the closing of Abadan, this was increased to 90,000 barrels.

Construction was divided into three stages. The first, involving the commissioning of the 90,000 bpd distillation unit—the biggest in Europe—was completed in 1953. The refinery was completed in 1955 with the commissioning of a platforming unit. Other main units in the refinery are a catalytic cracker, two vacuum distillation units, lubricating oil plant, and various treatment units.

**Europe**—At the end of the war, the BP group had only one operative refinery on the Continent. This was at Lavera, southern France, operated by BP's French associate Societe Francaise des Petroles BP. Capacity of this refinery was 10,000 bpd.

Europe's rapidly increasing demand for oil made it readily apparent that Lavera would not even be able to

**See BRITISH PETROLEUM Page 245**

**THEY HELPED PLAN THIS ISSUE. The 1956 Maintenance Issue Editorial Conference was held to establish the limits and type of editorial content for this issue. Attending the conference were the industry experts shown above, left to right: W. S. Janssen, American Oil Company; G. R. King, Humble Oil & Refining Company; P. E. Nicholls, Jr., REFINER staff, and C. W. DeLong, Shell Chemical Corporation.***

# FOREWORD

MAINTENANCE, like death and taxes, is forever with us. How well it is administered and engineered can mean the difference between profit and loss.

This is so clear, when the majority of the people are on the payroll for maintenance. And cost of maintenance is about the only controllable variable expense left to be improved. Force of competition sets basic feed stock and end product prices. Also process methods and capital costs are fairly well established, as are trends of taxes and pay rates.

The continuing demand for increased quality and variety of end products tends to enlarge the maintenance burden. This results from greater complexity of facilities and more involved processing techniques. The increasing size of plant adds to the problems of transportation, communication, supervision, and coordination.

The conduct in human relations is probably the most important single factor in the degree of accomplishment of the desired end result. And the bargaining unit relations will have much bearing on the final costs.

A major offset to the forces tending to increase expense is found in improved technology, better methods, tooling, effective engineering, planning and coordination. In this manner the highest utilization of manpower, equipment and material can be achieved. Too, the downtime of units will be minimized.

The size and importance of maintenance in the industry led PETROLEUM REFINER to establish special maintenance editorial coverage. This Maintenance Issue emphasizes two broad parts of the subject—Administration and Preventive Maintenance. We believe that in these two areas alone, major betterments in industry practice are possible. And to help accomplish the improvement we are presenting the authoritative views and experiences of the industry itself.

The approach to editorial content was set by industry men at the Maintenance Editorial Conference. In this way we seek to best serve the interests and needs of REFINER readers. Any credit due, goes to the industry men who set the guides for this Maintenance Issue.

To give some tangible measure to the cost of maintenance, we have the results of an industry-wide survey. These results relate cost to product values. This relation, in the final analysis then, is the only one that really counts. The difference between all cost and product value, spells out profit or loss, sink or swim.

To assist us, as a publication, in serving the industry and our readers, we need your help. We need your criticism and comment. Please tell us, when you have reviewed this issue, what we can do that will better serve your needs and interests.

P E Nicholls Jr.

* The attendance by executives, engineers, superintendents or other employes of oil companies at these editorial conferences does not constitute an endorsement of the REFINER or any other publication. The fact that these industry leaders are allowed to attend these planning conferences shows the interest which companies have in the planning of sound editorial content for the industry.

# Maintenance Cost Summary . . .

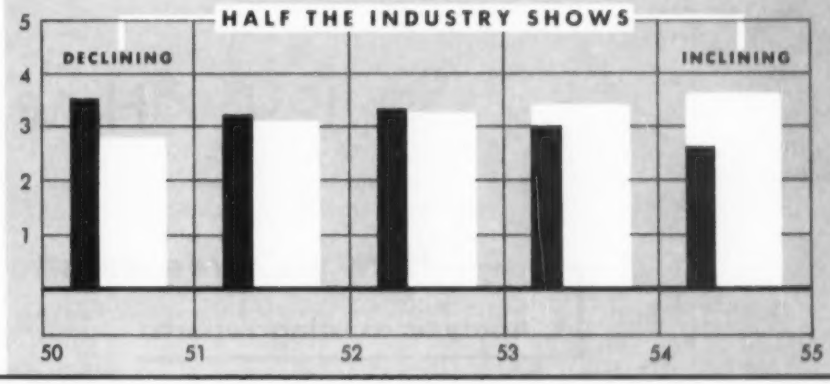
*(These data are industry-wide averages)*

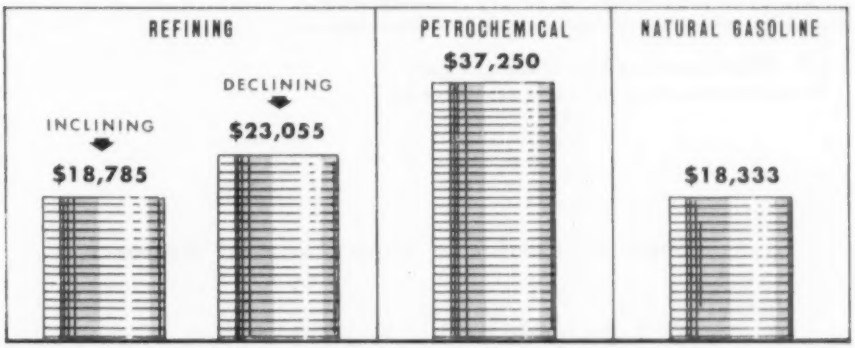
| | LABOR | + MATERIAL | = TOTAL |
|---|---|---|---|
| REFINING | 2.2% | 1.2% | 3.4% |
| PETRO-CHEMICAL | 3.7% | 2.4% | 6.1% |
| NATURAL GASOLINE | 4.0% | 3.6% | 7.6% |

**COST** as percent of product value

**TREND OF COST in refining**

(Cost as percent of product value)



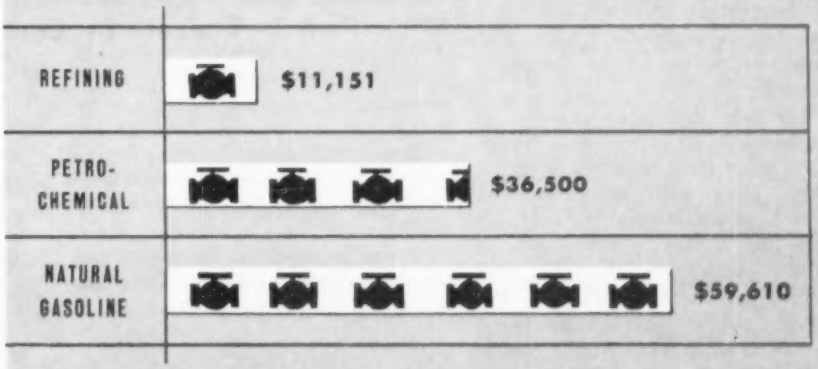



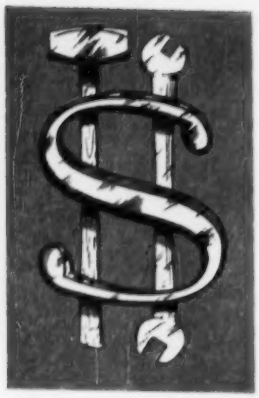

**MACHINE VS. MAN**

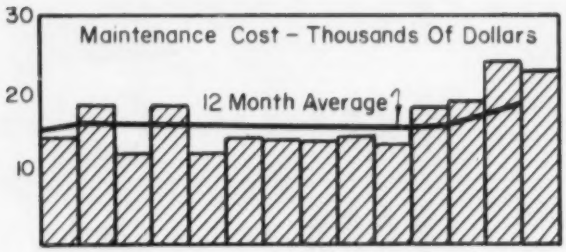
The amount of money industry will invest in equipment to do the job of one man.

**STORES AND SPARES**

Industry averages of inventory value per million dollars in product value.








# How Effective Is

## Here are three ways to find out:

- **Analyze existing reports.**
- **Use statistical activity sampling.**
- **Measure use of activity.**

**A. N. Smith**
Steinbergs, Ltd.
Montreal

## Part 1—Evaluate Your Current Reports.

## Part 2—Evaluate by Work Sampling.

## Part 3—Evaluate by Craft Measurement.

HOW OFTEN are complaints against a maintenance department justified? Many barbs are directed at maintenance people with little effort made to find out if the concern is justified.

Sometime the concern hinges on the relatively large bite that maintenance takes from total operating expense. More often it is centered around the uncertainty that generally accompanies any consideration of maintenance expense. Is it too large or too small? These questions continually plague plant people. They needn't, because there are many ways to evaluate the maintenance effort. These range from "rule-of-thumb" yardsticks to detailed measurement techniques involving standard time data.

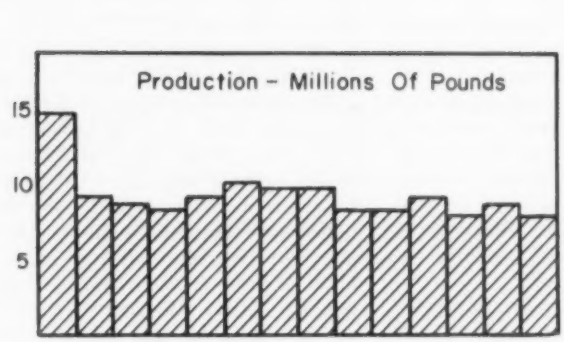
Three methods of evaluating any maintenance organization will be discussed.

**1.** The development of yardsticks taken from reports which are—or should be—used by most companies.

**2.** The use of statistical procedures for sampling "activity" in the maintenance organization.

**3.** The actual measurement of the efficiency with which maintenance uses this "activity."

The cost of using these techniques varies greatly. Using current reports



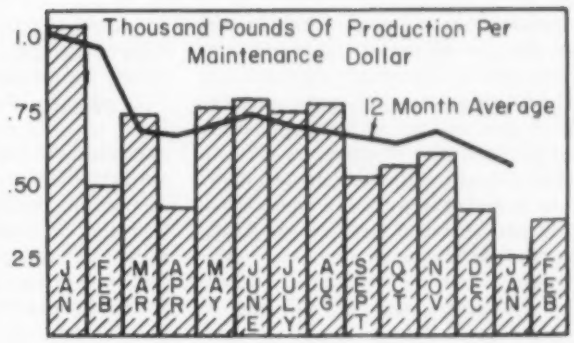




FIGURE 1—Maintenance cost graphs.

# Your Maintenance Dollar?

**TABLE 1—Summary of Maintenance Costs**

| DEPARTMENT | REPAIRS | | | | SERVICE | | | | ALTERATIONS | | | | GRAND TOTAL | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Labor | | Material | | Labor | | Material | | Labor | | Material | | Labor | | Material | | Total | |
| | This Month | Last Month | This Month | Last Month | This Month | Last Month | This Month | Last Month | This Month | Last Month | This Month | Last Month | This Month | Last Month | This Month | Last Month | This Month | Last Month |
| Plating Dept. | 279 | 254 | 10 | 18 | 72 | 69 | 10 | 15 | 35 | 33 | 18 | 22 | 386 | 356 | 38 | 55 | 424 | 411 |
| Sheet Metal | 1114 | 1018 | 245 | 161 | 127 | 182 | 43 | 51 | 125 | 118 | 67 | 53 | 1366 | 1318 | 355 | 265 | 1721 | 1583 |
| Final Assembly | 408* | 700 | 68 | 26 | 78 | 67 | 19 | 35 | 43 | 68 | 25 | 25 | 529 | 835 | 112 | 86 | 641 | 921 |
| Press Shop | 130 | 125 | 38 | 35 | 12 | 15 | 8 | 7 | 15 | 28 | 67* | 13 | 157 | 168 | 113 | 55 | 270 | 223 |
| Foundry | 380 | 279 | 78 | 67 | 45 | 32 | 11 | 15 | 41 | 25 | 20 | 10 | 466 | 336 | 109 | 92 | 575 | 428 |
| Sub-Total | 2311 | 2376 | 439 | 307 | 314 | 365 | 91 | 123 | 259 | 272 | 197 | 123 | 2904 | 3013 | 727 | 553 | 3631 | 3566 |

* Needs attention.

to obtain some idea of maintenance effectiveness is inexpensive. It's actually using what you already have. The work sampling procedure is, likewise, very easy on the pocketbook. But the expense of implementing a work measurement technique is usually great. However, it should be stressed that whatever the method followed, as long as some care is exerted, potential savings will likely greatly outweigh the cost.

It is important to realize that there are certain limitations to the use of certain of these yardsticks. In so far as their use is confined to analysis of one plant, they are extremely useful. However, if they are used to compare different plants, their value becomes negligible. Too many other factors tend to confuse the issue such as, type of process, age of equipment, use of facilities, continuous or intermittent operation, etc. These all play an important role in allowing any logical comparison.

**Evaluation Using Current Reports**—It has been mentioned that many useful yardsticks may be derived from normal monthly reports of practically any plant. Examination of these routine reports shows that many facts come to light, such as plant production in feet, pounds, gallons, etc., raw material costs, power costs, supervision costs, maintenance costs, etc. It is altogether probable that there will also be equipment breakdown reports, overtime reports, backlog reports, etc.

Each report may serve some useful

**Meet the Author**

A. N. SMITH, until recently with Canadian Industries, Ltd., now is maintenance superintendent for Steinbergs, Ltd., Montreal, Quebec. In plant maintenace work some 15 years, he spent the past 10 years with Canadian Industries, in a position responsible for installing control procedures in about 14 of its chemical plants. Born in Scotland and educated at Ontario's Queens College, Smith is author of a number of technical articles published in the U. S.

function but, as a yardstick for the evaluation of maintenance, is none too reliable. However, when some of these are combined and analyzed, they provide an interesting picture of maintenance effectiveness. For instance, you may have a report showing a higher production figure than last period, which everyone is happy to see. At the same time, the maintenance costs may be higher, which, by themselves, may or may not be unfavorable. But, if in the previous period you had developed a ratio of units of production per maintenance dollars, you might find that in this period, in spite of higher maintenance costs, the ratio is still a better one.

Further corroboration of a bettering maintenance picture may be developed if ratios of the maintenance dollar to the sales dollar, of maintenance payroll to total works payroll are also examined.

Let us look at some of these common methods of evaluating the maintenance function and let us describe them briefly. They will serve to illustrate the point that many plants have the means on hand to do their own evaluation if they will only use them.

**1. Maintenance Cost Classifications:** All maintenance expense should be classified for work handling purposes into these suggested categories—Repairs, Service and Alterations.

• *Repairs:* This includes the cost of time, tools and materials used by the maintenance personnel in repairing mechanical and building facilities. For example, this would authorize work on tools, electric motors, pumps, distribution lines as well as roof repairs, painting structural steel, etc.

There is a yardstick available if you so segregate your costs like this. Equipment repairs would be expected to vary directly with changes in production while building repairs would be fairly constant being little relation to production and usually set by "policy."

• *Service:* Includes the cost of time, tools and material utilized by personnel in maintaining buildings, grounds and equipment in a clean and tidy condition. This, in effect, is "policy" maintenance. Preventive maintenance inspection and overhaul programs would be a good example of this. Other examples are lawn maintenance, janitor service, etc.

In addition, this classification might cover all work performed as a service to operations that might be otherwise performed by operating personnel themselves. For example, of this classification are machine changes (because of production) handling materials, cleaning-up spills.

Usually you expect the former expense to be stable and expect the latter to fluctuate very irregularly.

• *Alterations:* Include the cost of time, tools and material utilized by maintenance personnel while performing improvements of a minor nature, relocations or additions to existing facilities, where capital investment is not involved.

This expense bears little relation to production and little relation to previous costs. It only reflects current concentration upon this type of work.

Usually, however, this type of expense is controlled that the total man hours so charged as a percent of the total work force hours seldom exceed 10.

If you haven't any classification whatsoever, the chances are that all your maintenance expense is charged as "repairs." As such, you may find it utterly impossible to explain why maintenance costs are increasing. This, unfortunately, will be the case in spite of the fact that you know and others know that the average maintenance organization is called upon to perform many jobs that, by no stretch of the imagination, could be called "repairs."

**2. Summary of Maintenance Costs:** This summarizes maintenance expense by each account and by previously described cost classifications. Usually, the current month's figures are compared to last month's, as shown in the exhibit (Table 1) but sometimes, in place of this, is an "average to date" column. Examination of each account will show whether the month's spending is normal or not. Sometimes, each figure is compared to a budgetted figure, which allows for still tighter control.

As management is liable to judge maintenance efficiency by the dollars it spends, this report develops a picture of the spending. By this type of report, management is given twelve opportunities a year to investigate the causes of performance variance.

**3. Maintenance Cost Graphs:** Figure 1. Of all the reports executives are called upon to scan, they are most concerned with those of production and sales. Maintenance people are not unaware of this. They, therefore, believe it is easier to justify maintenance expenditures by means of a definite relationship with production. Units of production divided by maintenance dollars will provide a ratio which, if graphed, will reflect present conditions.

An increase in this ratio indicates definite improvement, while a decrease may or may not point up an unfavorable condition. In order to decide this, we must look carefully for the main influence responsible for the decrease. It may be decreased production but higher maintenance costs or, it may be any combination of these. It must be remembered that an unfavorable ratio merely serves to focus attention—it does not condemn.

**4. Backlog Analysis:** Supervising personnel besides being interested in the present distribution of maintenance labor hours is naturally interested in the non-routine commitments ahead of each craft. Routine chores, if carried out properly, will require a fixed proportion of each craft's available time. It is the non-routine requests that can cause the most trouble and for want of a better word the sum of these jobs is called "backlog." When adequate conditions prevail, a backlog of 4/6 weeks provide a desirable work load. The variations from a backlog of this order indicate a smaller or larger crew necessary to carry the work load.

However, it should be recognized that the backlog, besides being a measure of the current work load, is extremely vulnerable to the issuing rate of job requests. When this is reduced for any reason, the edge of the backlog tool is blunted.

**5. Equipment Downtime Reports:** One of the most valuable tools in estimating the effectiveness of the maintenance department is tabulation of all equipment downtime because of repairs.

The basic reason behind a breakdown should not always be charged to poor maintenance but the length

the equipment is out of service should be so charged.

A report of this nature becomes very helpful if some value can be attributed to the lost time. If a machine is idle due to breakdown, it is obviously not producing and money is being lost. To-date, this type of expense has been recognized, but no use made of it.

Obviously, if it is possible to record the total expense of all equipment maintenance such as the direct repairs to it and the cost of lost production, you can develop a better appreciation of the amount of maintenance effort required.

**6. Equipment Record Reports:** Most cost reports scrutinized by management highlight department maintenance costs. However, maintenance supervision require a more detailed cost. They are vitally interested in knowing what specific pieces of equipment costs. It is not difficult to get this information. Any work order system worth the name has a means to indicate the equipment worked upon. If this is used, an internal costing of all equipment is easy. And as data builds up, patterns of repetitive repairs become apparent.

Many of us are quite familiar with "the 10 percent rule-of-thumb." You take the annual maintenance cost of any piece of equipment and divide it by today's replacement cost. If your ratio is greater than 10 percent, you should do some investigating; if it is less, you can be reasonably sure your costs are in line. This rule-of-thumb will not look after all conditions but it will serve as a starting point for cost scrutiny.

Recently a Canadian Management Consultant, B. A. Margo, of Montreal, Quebec, gave notice that he personally was not satisfied with the very arbitrary "10 percent" rule as a control measure. He set out to develop a formula which would supply a more realistic picture.

Right at this start, he pointed out that he wasn't trying to determine that very elusive answer of what should be the maintenance cost of each piece of equipment. Rather, he concentrated upon finding a formula which would permit the average organization to "spend" correctly.

He properly assumed that each organization is given only so much money to work with. Therefore, he attempted to correlate budget, replacement value and working conditions. His efforts were successful and any analysis of equipment cost using his formula is in my opinion much more exact than the rough rule-of-thumb.

It works like this:

1. Determine the plant maintenance budget as well as the plant replacement value. Let us say for example, the maintenance budget is $300,000 and the replacement value, $5 million. The ratio of maintenance budget to replacement value is $300,000/$5 million or 0.06.

2. Accept the limit life or replacement age as twice the average life. The allowable maintenance limit is then 2 × $300,000 or $600,000. The limit budget to replacement cost ratio is now 2 × .06 = 0.12/12 or 0.01.

3. Let us look at a piece of equipment which will cost $10,000 to replace.

4. Evaluate the service condition for this equipment, such as corrosion, capacity, usage, load, vibration, materials, etc.

5. Assign arbitrary point values to each of these conditions which will weight the relative importance of their influence on maintenance life of that equipment. For example, we may have developed this table:

| | | |
|---|---|---|
| Corrosion | 1.5 | |
| Capacity | 1.2 | |
| Usage | 4.0 | "Average" is 1.0 |
| Load | 2.0 | |
| Vibration | 1.0 | |
| Materials | 1.0 | |

6. Multiply each of these factors to determine a figure; what we call a wear factor. This, obviously, for our piece of equipment is 14.6. All similar pieces of equipment will have same wear factor.

7. Obtain the average wear factor for all the equipment in the plant. This is total of wear factors for each individual piece of equipment divided by the number of equipment. Let us assume that the plant wear factor is 20.0.

8. The average wear ratio for our particular piece of equipment is obviously 14.6/20.0 or 0.73.

9. The monthly limit of maintenance on this equipment is the replacement value × wear ratio × monthly limit constant for plant or— $10,000 × 0.73 × 0.01 = $73.

10. The annual permissible cost is then 73 × 12 or $876.

Using the old 10 percent rule, we would not be overly concerned as long as total annual cost did not exceed $1000. We see, here, therefore, that using service conditions as Margo has suggested might result in a better appreciation of budget spending.

This procedure merits more than passing consideration by many presently engaged in evaluating the maintenance effort. It would appear that Margo is very close to an answer to that dread question: "What should maintenance cost?"

**7. Intangible Factors:** There are certain intangible factors which should not be disregarded in evaluating the effectiveness of a maintenance organization. Many of these are based on the judgment of maintenance supervision and are extremely difficult to assess. Some are beyond the control of maintenance supervision and some impose working conditions which must be understood if over-all efficiency is to be determined.

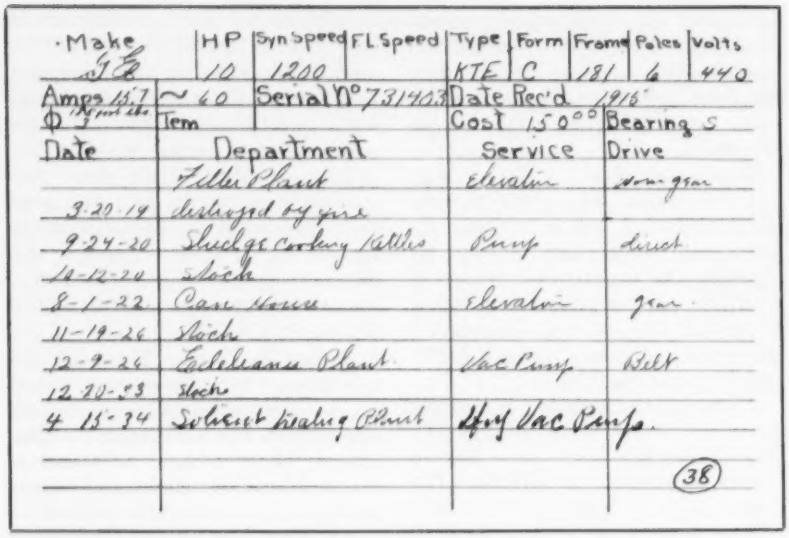
We do not propose to discuss them in any detail for their effect is well understood. It is sufficient to mention them. They include:

- Employe morale
- Union agreement
- Union relationship
- Product quality
- Housekeeping
- Selection, storage and use of spare parts
- Craft limitations
- Quality of maintenance
- Labor efficiency

The reason quality of maintenance and labor efficiency have been included in the list of intangibles requires some explanation.

It is extremely difficult to determine the quality of maintenance over a short period of time. For instance, bearings may be installed incorrectly, incorrect welding rod used, motors misaligned. Usually, resultant failure is the only determination of the quality of maintenance. The point is that a straight record of maintenance dollar spending is seldom enough. You *must* know that the spending is worthwhile.

***Part 2 will appear in a coming issue***



| Make | HP | Syn Speed | FL Speed | Type | Form | Frame | Poles | Volts |
|---|---|---|---|---|---|---|---|---|
| GE | 10 | 1200 | | KTE | C | 181 | 6 | 440 |

Amps 15.7 ~ 60 Serial N° 731403 Date Rec'd 1918
Φ 3 Tem Cost 150.00 Bearing S

| Date | Department | Service | Drive |
|---|---|---|---|
| | Fuller Plant | Elevator | worm gear |
| 3-20-19 | destroyed by fire | | |
| 9-24-20 | Sludge Cooling Tables | Pump | direct |
| 10-12-20 | Stock | | |
| 8-1-22 | Cane House | Elevator | gear |
| 11-19-26 | Stock | | |
| 12-9-26 | Exhaleanes Plant | Vac Pump | Belt |
| 12-20-53 | Stock | | |
| 4-15-34 | Solvent Heating Plant | Hvy Vac Pumps. | |
| | | | (38) |

**FIGURE 1—Motor record card used in maintenance record set up in the refinery in 1915.**

# How to Avoid Power Failures

**Here are the results of an effort started 40 years ago to improve electrical equipment performance.**

**Alex Lohse and R. L. Mallatt**
Union Oil Company of California
Rodeo, California

DECREASING ELECTRICAL failures by a simple and effective preventive maintenance program has been accomplished at the Oleum Refinery of the Union Oil Company of California.

This program has the full support of top management, design engineers, and shop foremen. Begun in 1915 by the company's chief electrician, it had its inception in the motor record card. (Figure 1.) Down through the years this program was supplemented by many others, and at present consists of preventive practices in the following divisions.

- Power Distribution System
- Motors and Motor Circuits
- Lighting
- Communications

By following preventive maintenance in these divisions, with funds provided by management, thorough design engineering and conscientious work performance by the shop forces, electrical failures have been averted. By averting electrical failures, the "on stream" time of the refinery has been increased. Oleum Refinery is a 65,000 barrel per day integrated oil refinery. The maximum electrical demand on a half-hour basis is 15,000 KW.

**Power Distribution System**—Preventive maintenance of our power distribution facilities has paid handsome dividends. Electrical energy has become the primary source of power for the refinery. Power failures rob refiners of profits. Power failures have been eliminated by the simple expedient of regular inspection and repairs.

Generally speaking, switchgear is quite troublefree. At the main 2.4 KV and 4.0 KV substations the oil has been tested and the circuit breaker contacts inspected once each year. With a back-to-back oil circuit breaker arrangement the 2.4 KV gear can be inspected as desired by installing the spare breaker in the metal-clad gear and servicing each breaker. The 4.0 KV air break gear is taken out of service during the annual gasoline process unit shut-downs and the equipment is serviced and cleaned. Transformers receive only nominal attention. Oil level, oil leaks, and loose connections are checked annually and transformers are painted every 4 or 5 years. It has been found that modern, weather-proof unit substations give remarkable service. Whenever possible, this type of equipment is installed in preference to single phase transformers.

Major power failures during the last 40 years have been due essentially to weaknesses in the overhead power lines. Windstorms, heavy rains, and corrosion have been the principle contributors to such interruptions. During the five-year period (1945-1950), two of the five 2500 KVA circuits in the plant were redesigned and later reconstructed. Power poles were strong but carried undersized wire, crossarms, and poor quality hardware. Bare wire was replaced with TBWP wire, 3¾-inch x 4¾-inch x 7-foot crossarms were replaced with 4-inch x 5-inch x 8-foot arms, only angle crossarm braces are now used, and pressed steel hardware has been entirely replaced with forged steel hardware. The refinery now has eight 2500 KVA overhead distribution circuits. Each summer we have a line crew inspect, clean, repair or renew, and paint these facilities. The work is scheduled in such a manner that each structure is inspected every other year. This crew normally works from 4 to 5 months on this preventive maintenance assignment. From 1950-1955 we have had no failures. In the past we experienced as many

as four power failures per year. We remember one on a heavily loaded circuit in the middle 1940's that cost us $25,000 in unit downtime alone.

The record keeping system is simple. Each structure, transformer, and unit substation has a simple numerical designation. Records for the pole structures and unit substations are kept in a simple unit sub log in ledger form. Transformer records and repairs are logged on individual record cards similar to those used for motor records. Last, but not least, the people who execute this program are interested in obtaining the best results for each dollar in equipment investment.

**Motors and Motor Circuits**—In this day of increasing electrification of refineries it becomes more important than ever that the electric drives be kept running on a full-time basis. We have been able to meet this demand at a reasonable cost by a program of preventive maintenance on our motors and motor circuits.

Our program of preventive maintenance for electric motors and circuits is the outgrowth of the years of experience gained since the original motor record was filled out. The program consists of three essential points:

1. Proper lubrication and repair of motors.
2. Periodic inspection and repair of circuits.
3. Proper design.

**Proper Lubrication and Repair of Motors**—Our lubrication program is set up and carried out in its entirety by personnel in the Electrical department. They have the sole responsibility for the selection of the lubricant and actual lubrication of the motor. The department is assisted in carrying out its responsibilities by the operating personnel in their observations of abnormal operations of any motor. By having one group responsible for all motors in the refinery it is possible to control the frequency and way that each motor is lubricated. Thus the evil of "over-greasing" is minimized.

We have at the present time approximately 1000 three-phase motors that are being maintained. The voltage varies from 208 to 4160. The horsepower ranges from 1 to 3500 hp. The frequency of lubrication is determined by past experience with the various types and kinds of motors. In general, we lubricate each grease filled bearing once a year. In specific cases, we may lubricate twice a year when motors are in particularly hard service. Lubrication records are kept on cards.

The man lubricating motors has a twofold responsibility. He must first lubricate the motor with the proper type and proper amount of lubricant. His second responsibility is to visually inspect the motor and report any condition that will affect the operation. This condition is evaluated by the foreman of the electric shop, who determines the proper action to be taken. In most cases, repairs are made at the next scheduled shutdown.

Critical motors that have been in service for five years are removed for a general overhaul and inspection during regularly scheduled shutdowns. These motors are sent to an outside firm. We have found that it is more economical to use the services of a motor repair vendor than to maintain our own motor repair shop. This eliminates the need of carrying large stocks of repair parts and expensive repair equipment. The motors that are not critical to a unit's operation are removed for overhaul only once in every eight years unless inspection reveals the necessity for an earlier removal. Many motors in the refinery, outside of the unit boundaries that are on a part-time or standby basis, are only removed when there is an indicated trouble. We have one motor in the refinery on a machine in the boiler shop that has been in service for 37 years without any maintenance other than lubrication and external cleaning.

Figure 3 shows the growth of the number of motors in the refinery by year and the number of bearing failures. We make no claim that we have eliminated motor failures, but we have, as indicated by the graph, reduced our failures significantly.

**Periodic Inspection and Repair of Motor Circuits**—As in the case of the preventive maintenance of motors, Union takes advantage of the periodic scheduled shutdown of operating units to maintain its motor circuits. During the shutdown, each motor circuit is megged and the reading compared with the reading obtained at the previous shutdown. Sharp drops in insulation values are investigated for the cause. Below a prede-

MOTOR CONTROLLER RECORD

| STYLE NO. | | | TYPE | CONTROL VOLTS | PH. | CYCLE |
|---|---|---|---|---|---|---|
| LOCATION | | O. L. COIL NO. | HOLDING COIL NO. | | C. T. RATIO | |
| UNIT | CIR. | INSTALLED | POTENTIAL TRANSFORMER NO. | | | |
| | | | FUSE OR BREAKER NO. | MAX. AMPS. | | |
| | | | RENEWAL PARTS BULLETIN NO. | | | |
| | | | GALS. OIL REQUIRED | | | |
| | | | P. T. FUSE CAT. NO. | TYPE | | |

FIGURE 2—Motor Controller Record card which is used to accumulate and record all information on the unit and its circuit.

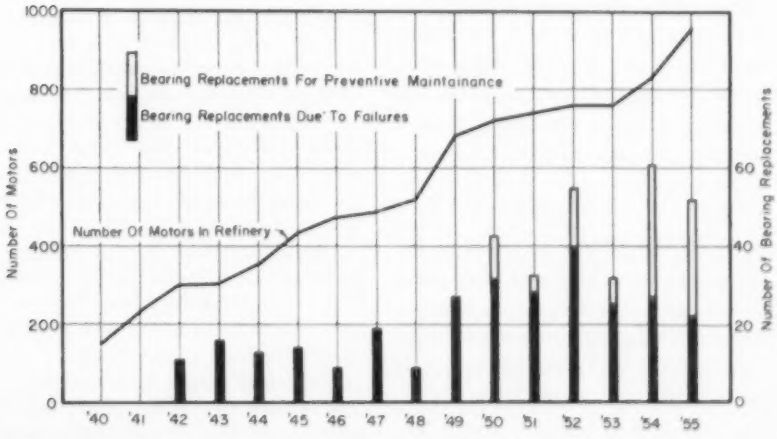



FIGURE 3—Graph showing increase in the number of motors in service and bearing performance.

MAINTENANCE

termined value of resistance, the circuit is replaced.

Each motor controller is opened and inspected for worn parts. The overload protective device is actuated and calibrated with the use of a portable variable current transformer. Oil from the oil filled motor controllers is checked for breakdown voltage and replaced when necessary.

The first day of each shutdown is devoted to the checking of the incoming switchgear and the power transformers. During this time the power to the plant is disconnected.

Any defects in the conduit runs observed by the electricians during the plant's operation are repaired at this time.

At the end of the shutdown each motor has been inspected and repaired where necessary, each circuit has been checked for its insulation value, and each controller inspected and calibrated. With this maintenance accomplished, we have experienced continuous electrical operation of the plant until the next scheduled shutdown.

**Proper Design**—All of the foregoing maintenance would be of no avail if the motors and motor circuits maintained were of poor quality or were improperly installed. No preventive maintenance program can keep a continuous overloaded motor running properly. This means that proper engineering is essential in a good preventive maintenance program. Maintenance of equipment must be a prime engineering factor when the plant is being laid out.

**Lighting**—In general, the lighting systems have proven to be well designed and dependable. Number 12 wire or larger is used to eliminate voltage drop. In all hazardous areas and areas exposed to the elements we normally install explosion-proof fittings. Don't raise your eyebrows too high. Maintenance repair costs soon eat up the difference in cost between weatherproof and explosion-proof fittings in the small sizes. Lighting fixtures are a good quality single-lensed diffused light in operating units, refractors for street lighting, and fluorescent fixtures in most offices.

There are some 6000 fixtures in the refinery. By and large, electrical failures in the lighting distribution system are infrequent. However, high lamp replacement costs caused concern in 1952. Labor costs for replacing lamps on an "as they fail" basis were very high. A long-life lamp group replacement program was begun in the fall of 1952. All lamps are now replaced on a 1700-hour service life basis. In other words, all lamps are replaced twice a year. Fixtures are cleaned and washed only as dictated by operating conditions during these replacements. This program has resulted in a maintenance situation which in itself is "preventive." The end results are better service at a 20 percent saving.

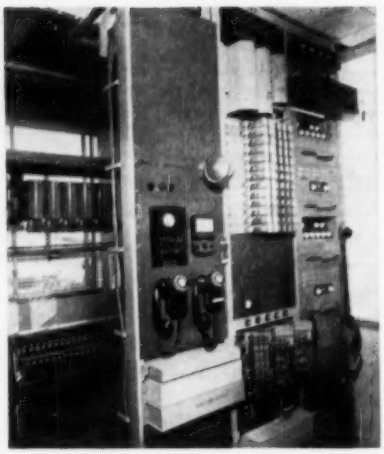


FIGURE 4—Communications equipment racks arranged to provide easy access for servicing.

**Communications**—Communications has become a major part of the refinery's electrical facilities. The modern form of communication is becoming increasingly more complex and therefore requires greater attention be given to its preventive maintenance. Communications may be thought to include anything from the telephone to an alarm circuit. Each of these is a form of communication and must be ready to operate when it is needed.

The telephone system is a private automatic exchange. It consists of automatic equipment required for 350 phone numbers, 500 telephone handsets, and approximately five miles of cable facilities.

The maintenance of this equipment is carried out by two communications men. These men clean and inspect the automatic equipment daily. The cable system is inspected on an annual basis to detect cable trouble before the rainy season. Handsets are cleaned and repaired by these men periodically. These communications men also maintain the emergency public address system and the local intercommunication sets. Preventive maintenance of these systems includes a periodic group replacement of the electronic tubes.

Figure 4 shows the panel type of construction used for the emergency public address system. This allows immediate inspection and easy accessibility to the component parts of the system.

The radio system is inspected, calibrated, and repaired by a licensed firm on a monthly schedule. Emergency repairs are made on a 24-hour callout basis.

Alarm and annunciator systems are repaired by scheduling repair orders periodically. The period is determined by operating experience. ##

## Meet the Authors

Lohse

Mallatt

ALEX LOHSE, who is construction supervisor for Union Oil Company of California at its Oleum refinery, has been with the company ten years. Now in charge of all new construction designed by the refinery's Engineering department, Lohse started with the company in 1945 as an electrical engineer, spent ten years in that position, and was advanced to master mechanic early this year. Since then he has been moved up to construction engineer. Lohse is an electrical-engineering graduate from the University of Nevada.

R. L. MALLATT is foreman of the electrical shop at Union Oil Company of California's Rodeo, Calif., refinery. Previously assigned to Union's Oleum refinery, he has been an electrical engineer for the company four years. He holds a B.S. degree from Oregon State College.

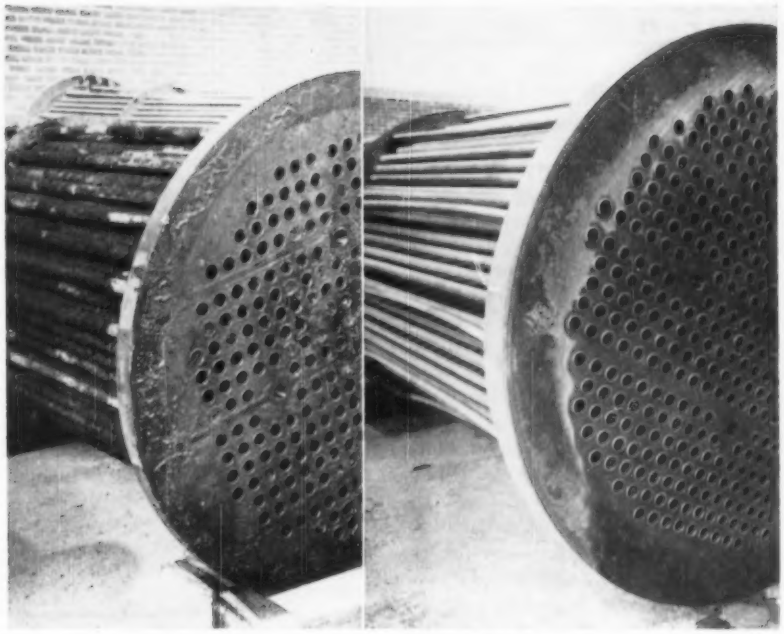


FIGURE 1—Bundles before and after hydro-sand blasting.

# Exchanger Preventive Maintenance Pays

**Here's how teamwork and good methods pay off in reduced downtime and better performance.**

**R. E. Butler and R. P. Coleman**
Union Oil Company of California
Wilmington, Calif.

COORDINATION IS a must between Operating, Maintenance and Inspection departments if a preventive maintenance program is to work successfully. The maintenance of more than 700 heat exchangers and submerged condenser bundles at the Los Angeles refinery of Union Oil Company of California is an excellent example. Performance of these equipment units has much to do with meeting production goals.

Performance and corrosion records of exchangers are kept by the Operating and Inspection departments, respectively, and provide the necessary information for establishing turnaround intervals, and for scheduling maintenance work on a planned basis. Modern cleaning methods, power tools, complete testing equipment, adequate shop facilities, and trained personnel enable the Maintenance department to carry out its program of planned and preventive maintenance.

**Operating Department**—A large part of the responsibility for the preventive maintenance of exchangers is dependent upon the Operating department. Many of the measures to prevent or retard corrosion are performed by the operators in the units.

In the fluid catalytic cracking gas plant section where ammoniated water wash and air injection are used to prevent hydrogen attack to exchangers and other equipment, the activity of hydrogen probes, which are located at critical points in the system, is observed and recorded. Water wash samples are taken so they can be tested in the laboratory for cyanide, thiocyanate, and pH. The controlled injection of ammonia organic inhibitors in crude topping and thermal cracking units for pH and corrosion control is another example of the operator's role in preventive maintenance.

Over 26,000 gallons per minute of salt water cooling are used in exchangers and condenser boxes throughout the refinery. Careful control of this coolant is necessary to maximize its benefits and yet prevent excessive corrosion and damage to bundles. Tubeside velocities of saltwater are maintained as near as possible at three feet per second, and water temperatures are not allowed to exceed 120 F. Careful screening of the saltwater is done to remove marine life and foreign materials. In addition, consideration is given to the prevention of air entrainment in the system. Magnesium anodes are used with submerged bundles in salt water condenser boxes to reduce corrosion to heads, bolting, and submerged piping. Plastic tube protectors are installed in the inlet passes of shell and tube exchangers to prevent tube-end damage that would otherwise result from impingement and erosion. (Figure 6.)

Corrosion by cooling tower waters is controlled by the Operating department through the addition of water-treating chemicals. Consideration of the type of treatment is based on the corrosion load, scale tendency, pH, and algae forming characteristics of the water in question. Routine laboratory analysis is performed on water samples, and special analysis is made if the treatment appears to be inadequate.

The cleaning interval of exchangers is established by the Operating de-

partment from process studies made on each exchanger. The reduction of heat transfer rates determines the cleaning interval and influences scheduled turnarounds when maintenance and inspection work is performed on a planned basis.

To further assist Maintenance and Inspection to utilize full bundle life, the Operating department provides the Inspection department with the maximum operating conditions of temperature and pressure, for which the exchangers are to be maintained. In addition, the exchangers are classified as "critical" or "non-critical" depending on whether they must operate without maintenance between turnarounds or whether maintenance can be performed during unit operation.

**Inspection Department**—Functions of the Inspection department toward a preventive maintenance program at Los Angeles refinery include inspecting the equipment and keeping progressive records of its condition, ordering replacement and spare parts and warehouse stock, and recommending repairs and improvements. Recommendations are made to initiate a process investigation, a design change, an operating adjustment, or merely a straight substitution of a superior material—depending upon economic considerations of the case at hand.

Heat exchangers are scheduled for inspection when they are opened for cleaning or when the inspection interval based on corrosion rate has expired. The fouled condition of the bundle is observed and recorded as it is removed from the shell. (Figure 2). All components of the shell and bundle are then cleaned and inspected. From the results of this and previous inspections, any change in corrosion rate is usually readily evident. It is the Inspector's responsibility at this time to anticipate the extent and future date of any material replacement or repairs, and to establish the future inspection requirements.

Any unusual condition found at the time of inspection is promptly called to the attention of the Operating and Maintenance departments for immediate action or preventive measures or for preliminary planning of future considerations. The effectiveness of previous preventive measures or repairs and the need for future corrosion protection measures, design and material changes can best be evaluated and established at the time an exchanger is open.

Included in the methods used for inspecting exchangers are visual examination, ultrasonic testing (Figure 3), magnetic particle inspection, X-ray, and beta ray, to name but a few. Under certain conditions samples are removed for metallurgical examination. It is important to make a complete analysis of the fouled, damaged, or corroded condition at the time an exchanger is open in order to determine and justify the inspection means used.

Exchangers within the refinery are designed, repaired, and maintained in

**Meet the**

R. EVERETT BUTLER has been engaged in refinery-inspection work for the past five years, three of which have been with Union Oil Company of California. A mechanical engineering graduate from the University of Colorado, he is now engineer in charge of heat-exchanger inspection at Union's Wilmington, Calif., refinery.

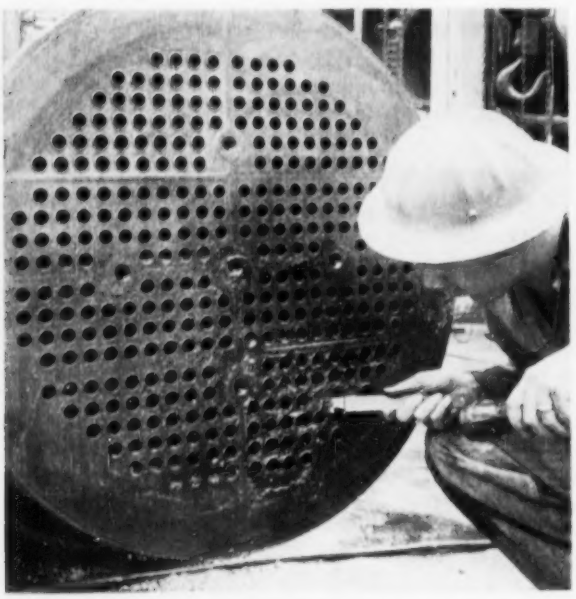


FIGURE 2—Exchanger bundles inspected for tube and shell side fouling when removed from the shell.

FIGURE 3—Inspection of exchanger shell uses ultrasonic thickness measuring instrument.

## Authors

RUSSELL P. COLEMAN, boilermaker-welder foreman for Union Oil Company of California at its Los Angeles refinery, has a background of 26 years in the plant's Maintenance department. During that time he has served as shift maintenance foreman, area foreman and sheetmetal foreman.

accordance with the established Pressure Vessel Codes, Exchanger Manufacturers Standards, Union Oil Company Material and Design Specifications, and Union Oil Company Maintenance Procedure Specifications. The Material and Design Specifications eliminates troublesome design features and provides for construction in excess of the minimum allowable by the Pressure Vessel Codes and Manufacturers Standards where necessary. It is the inspector's responsibility to see that material purchased or repairs recommended meet the above requirements.

**Maintenance Department**—The Maintenance department is charged with the responsibility of actually making the repairs and performing the cleaning operations recommended and predicted by the Operating and Inspection departments. This work must be done in a thorough, first-class manner and each exchanger carefully tested before it is returned to service. A hurried, "patch work" job may mean another shutdown.

Whenever possible cleaning and repairs are accomplished at the shop where complete mechanical facilities are available. Also, whenever conditions will permit, exchanger work is done on scheduled turnarounds on a planned basis. Where, because of rapid fouling, one or two "critical" exchangers could shorten the run of a major unit, bypasses are provided so these bundles may be cleaned during the run.

During scheduled turnarounds of the units, exchanger repairs are made primarily from recommendations based on the results of inspections made during previous turnarounds and predictions of fouling from operating records. From this information manpower and facilities are made available by the Maintenance Planning Office to make major repairs to exchanger bundles, shells, tubesheets, and heads.

Exchanger bundles scheduled for cleaning or retubing are removed from their shells and hauled to the shop on a straddle truck. Both the inside and outside of the tubes of all bundles are cleaned in the hydro-sandblast unit. The installation of this unit in 1954 has reduced cleaning time of bundles by 50 percent. The method produces cleaner bundles than was possible by previous methods, thus improving heat transfer, lengthening runs, and facilitating inspections.

The entire circumference of the tubes of square pitch bundles can be cleaned to bare metal throughout the diameter of the bundle. Triangular pitch bundles can be successfully cleaned except for the center core. In this case, complete removal of the material between the tubes is accomplished but some deposit may be left on the circumference of the tubes in the center of the bundle. (Figure 1.)

The hydro-sandblast unit operates with fresh water pumped at 1600 pounds per square inch through a high pressure hose to a mixing chamber

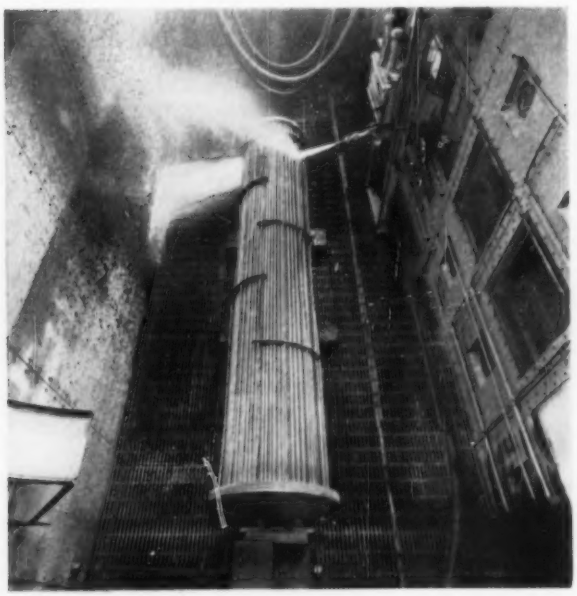


FIGURE 4—Hydro-sandblasting tube bundle.

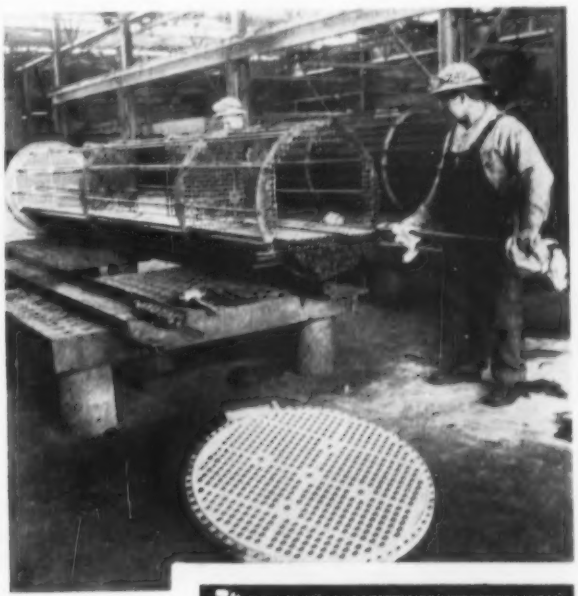


FIGURE 5—Reassembling exchanger tube bundle.

MAINTENANCE

where clean blasting sand is injected from a Neoprene lined pump. The mixture then flows through abrasive resistant hose to the gun and the blasting nozzle. The blasting nozzle is mounted on a track and movable carriage, and is operated by remote control from outside the hydro-sandblast room. With the bundle set on a rotating assembly, the operator can maneuver the nozzle the full length of the bundle and across one end. Cleaning the inside of tubes is accomplished by rotating the bundle slowly while making slow vertical passes across the tubesheet. (Figure 4.)

After hydro-sandblasting is complete, the bundle is shop tested for tube or roll leaks and returned to the unit. It is reinstalled in the shell using a complete set of new gaskets and given a final tube and shell side hydrostatic test.

Exchanger bundles scheduled for either partial or complete retubing are moved from the hydro-blast unit to the shop for dismantling. We have found that it does not pay to replace one or two tubes at a time except under unusual conditions. If tubes start to fail the bundle is retubed or at least the entire depreciated pass replaced.

All components of the dismantled bundles are thoroughly inspected. Tubesheets are checked to determine if the gasket surfaces will require machining due to excessive corrosion or erosion. Tube holes are inspected for out-of-roundness or damaged serations, cross baffles are straightened and realigned, and tie rods and spacers are renewed or repaired. Channel and floating head gasket surfaces are checked and, if required, they are overlaid with weld metal and remachined to the original dimensions. Channel pass ribs are replaced or overlaid with weld metal as necessary.

FIGURE 6—Plastic tube protectors are installed on inlet passes of saltwater bundles to prevent tube-end impingement and corrosion.

When the bundle carcass is ready for inserting the tubes, care is exercised that the portion of each tube entering the tubesheet is free of all oil, grit, mill scale, or rust. (Figure 5.) With the bundle completely assembled, overall dimensions are checked and the tubesheets properly set. Six to eight tubes are then lightly expanded at four locations around the periphery on vertical and horizontal center lines, and in a square of tubes at the center of the tubesheet to serve as anchoring stays. Tubes are expanded in a square pattern, working from the center of the tubesheet out, with the corners of the square on the horizontal and vertical axis of the bundle. (Figure 7.) This pattern of expanding tubes prevents bowing or warping of the tubesheets. Controlled expansion of exchanger tubes is used to insure uniform tightness and holding strength in every tube joint, and to prevent distortion or breakage of the ligaments in the tubesheets. Controlled expansion of tubes has also reduced job time through the reduction of leaking tube joints that would require re-rolling and re-testing. The re-tubed bundle is then shop tested and returned to the unit for installation.

In order to reduce down time and peak work loads on turnarounds we have a number of spare exchanger bundles. Fouled or depreciated bundles are removed and replaced with spares. The removed bundles are then cleaned and repaired after the unit is returned to service and manpower and equipment requirements are not so critical. Considerable savings can be made by standardization of exchangers so that fewer spares can take care of a greater number of exchangers.

When only minor repairs or cleaning are necessary, or in the case of condensers with fixed tubesheets, repairs are made in place.

When making tubeside repairs or cleaning in place, the exchanger is first isolated and depressured. The channel cover is then removed and the shell side hydrostatically tested. Testing in this manner will indicate a tube or roll leak, or a floating head gasket leak. After the initial shell test is completed, the shell cover and floating heads are removed, and the bundle prepared for cleaning.

If the tubeside fouling is a soft scale or sludge, such as that deposited by saltwater, effective cleaning can be done using a hydrojet followed by a wire brush. (Figure 8.) In cases where a hard scale is found, the tubes are cleaned with a hydrodrill or dry sandblasting. ##

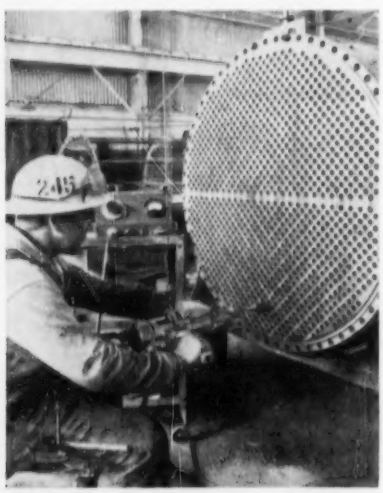


FIGURE 7—Tubes are expanded in square pattern working out from center.

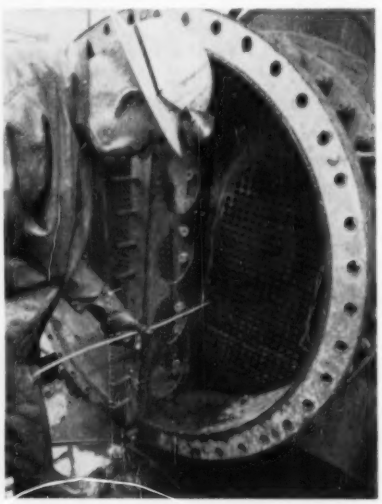


FIGURE 8—Hydrojetting the tubeside of a surface condenser in place.

# Planned Refinery Maintenance

**Engineering control . . . good records . . . and clearly defined organization go together to produce—results.**

**W. G. Elgie**
The British Petroleum Company
Kent Refinery, England

ENGINEERING MAINTENANCE at the Kent refinery of The British Petroleum Company is a major operation which extends over an area of 900 acres of which 650 acres are occupied by process plant or tankage. The network of major pipe racks is eight miles long and the road system extends for 22 miles. There are six miles of railways and seven oil-loading jetties. The strength of the maintenance force is about 540 men, of whom about 360 are employed on work in the field, 50 in central workshops, and the remainder as mobile equipment or transport drivers, etc. This labor force is divided into nine trade groups.

The fundamentals of good plant maintenance can be briefly stated as prevention, correction and finally elimination of breakdowns. The method whereby this object is achieved can be expressed as the answers to four questions: (1) What is to be maintained? (2) How much work does it need? (3) How is the work to be done? (4) Who does it?

**What Is to Be Maintained?**—The first essential is the making and keeping of an inventory of all equipment. As everything on or appertaining to a plant requires work to be carried out on it at some time or other, it naturally follows that all mechanical, civil, and electrical equipment must be broken down to individual components and catalogued. The magnitude of the task at Kent refinery is best indicated by this inventory, which includes (in round figures) 80 fractionating columns, 700 unfired pressure or non-pressure vessels, 550 heat exchangers, 750 pumps, 90 compressors and blowers, 120 engines and turbines, 300 storage tanks and a very large number of valves and other smaller components. From this inventory the plant record and history cards are developed, of which there are several thousand. By their use the apparently complicated system of planning and scheduling necessary in modern works can be simply and economically dealt with. Figure 1 shows the card used in the index system at Kent. Note particularly the space given for the history of the piece of equipment concerned, which is carried on to continuation cards throughout its life. The history of the centrifugal pump of Figure 1, for example, is shown in Table A.

The provision of data for this history is an essential part of the maintenance scheme and comes from documents authorizing maintenance as will be seen later.

**How Much Work Does It Need?**—Having established how much plant is to be maintained, the next step is to assess the work to be done on that plant. Each item of equipment must be studied and a preventive maintenance scheme devised to ensure maximum efficiency. The ideal would be to adjust all maintenance work so that plant failures were anticipated by a small margin of time. This involves establishing an inspection procedure which operates in two ways: (1) A visual or working inspection which consists of observing equipment in operation, detecting potential breakdowns and making small adjustments. This is carried out by refinery maintenance personnel. (2) Shutdown inspection which involves assessing the extent and rate of wear and general conditions of the

EQUIPMENT DATA — CENTRIFUGAL PUMPS

FIGURE 1—Typical equipment index card.

**TABLE A**

| | Report No. | Date | Correspondence File | Correspondence Date | Job No. | Man Hours | Cost |
|---|---|---|---|---|---|---|---|
| B.1. Service completed—Gland Nuts on Studs eased off and Glands adjusted | | 15- 6-53 | | | | | |
| C.1. Service completed | | 4- 9-53 | 4631 | | | | |
| New Gland Studs and Brass Nuts fitted | 7453 | 8-10-53 | 9993 | | | | |
| Packed with S.S. 3 and 110 MP. Alternate | 8521 | 16-11-53 | | | | | |
| Glands repacked with 110 AL and S.S. 3 Alternate | 628 | 28- 4-54 | | | | | |
| C.1. Service | | 4- 8-54 | | | | | |
| B.1. Service | | 1-11-54 | | | | | |
| C.1. Service | | 7- 2-55 | | | | | |

equipment. This is carried out by inspection department personnel.

An important feature of the system is that the inspection department is organized separately from and as a service to the maintenance department, answerable directly to the chief refinery engineer. The fact that the inspection department operates as a control on the quality of the maintenance department's work provides an added reason for separate organizations.

The working inspection may be compared with regular servicing on a car at intervals of 500, 1500 and 5000 miles. Such specifications have been produced at Kent for every piece of equipment in the refinery, and these are constantly being revised in the light of experience, thus fulfilling the rule that a corrective approach must be taken. Instructions for three stages of working inspection for centrifugal pumps are shown in Table 2.

**TABLE 1**
**Division of Responsibilities at Plant Engineer/Foreman Level**
**Plant Engineer**

Over-all responsibility for an area and for the maintenance of the area in accordance with:

(a) Process needs for efficient plant operation and plant availability.
(b) Good engineering practice, including considerations of economy and safety.

**Duties**

(a) Liaison with process regarding work to be executed.
(b) Correlation of work requests from all sources and authorization of necessary work.
(c) Pre-engineering of such work involving:
1. Engineering appreciation.
2. Fault analysis.
3. Initiation of preventive maintenance measures.
4. Economic analysis.
5. Initiation of design and development which will be carried out by other departments.
6. Estimates of work content.
7. Procurement of all material down to level where material is available for collection from Stores by field forces.
8. Planning of work load and integration of work (service is available from Coordination Group on long term and major works).
9. Procurement of labor to execute approved work in accordance with a refinery-wide plan for labor allocation. Labor allocation is made by A.R.M.E. (Plant).

(d) General direction of Area Foreman on authorized work in accordance with approved plan.
(e) Progressing of work from day to day.

**Area Foreman**

Direct field control of all work authorized by the plant engineer within his area to the satisfaction of the plant engineer.

**Duties**

(a) Process liaison regarding safe working conditions and occupation of plant for works actually being executed.
(b) Coordination of allocated labor and crafts on authorized work.
(c) Productivity.
(d) Inspection of quality of work.
(e) Initiation of minor maintenance works essential for hour to hour running of the plant.
(f) Arranging for collection and delivery of materials from Stores to job.
(g) Utilization of allocated equipment.

**Craft Foreman**

Craft foreman is responsible for detailed labor administration and implementation of company personnel policies for all men in his trade regardless of the area in which the men may be working.

**Duties**

(a) Posting of labor in accordance with allocations.
(b) Trade training and uniformity of methods and practices.
(c) Quality of work.
(d) Efficient tooling.
(e) Clothing, etc.
(f) Testing recruits in trade practices.
(g) Job discipline.
(h) Safe-working methods in accordance with the refinery regulations.
(i) Assistance to Area Foremen on supervisison of work within his capacity as the expert in his craft.

**TABLE 2**
**Service Specifications A.1.**
**Centrifugal Pumps—Daily Service RE. 28**

1. Examine stuffing box for excessive leakage—adjust if necessary—check gland seal oil system if fitted—OR
1a. Check mechanical seal for leakage, check coolant delivery and seal oil system.
2. Check that constant level lubricator is full and set to correct level.
3. Check that cooling water is turned on and flowing freely.
4. Check that coupling guard is properly fixed in position.
5. Check pump for vibration or rough running.
6. Check for general cleanliness and safety.
7. Check power input to driver (amperage in the case of an electric motor, nozzle steam pressure and number of nozzles open in case of steam turbines). If abnormal investigate operating conditions.
8. Report any defects outside the scope of this service.

**Service Specification B.1.**
**RE. 28 (a)**
**Centrifugal Pumps—2000 Running Hours Service**

1. Empty, clean and refill oil reservoirs.
2. Run up pump and carry out provisions of Service Specification A.1.
3. Investigate any irregularities revealed during execution of A.1. Service.

**Service Specifications C.1.**
**RE. 29**
**Centrifugal Pumps—4000 Running Hours Service**

1. Disconnect coupling and examine.
2. Clean out water jackets and piping. Flush or circulate HCl to remove scale if necessary. Flush afterwards with water.
3. Empty, clean and refill oil reservoirs.
4. Check alignment of pump and driver.
5. Box up coupling and fit coupling guard.
6. Run up pump and carry out provisions of Service Specification A.1.
7. Investigate any irregularities revealed during execution of A.1. Service.

Shutdown inspections take place at set intervals, many of which are determined statutorily, otherwise these schedules, like those for working inspections, are continually under review. Intervals between shutdown inspections can be lengthened by instituting a continual study of design, materials, method of construction, and so on with the object of reducing maintenance effort and increasing production time. Naturally, much information from shutdown inspections is relevant to re-assessment of working inspection schedules.

**How Is Work to Be Done?**—As in the system and methods of inspection, close and continual study is made of the methods to be used and the tools to be employed on every job. Since it is accepted at Kent that the "one best method" should be used

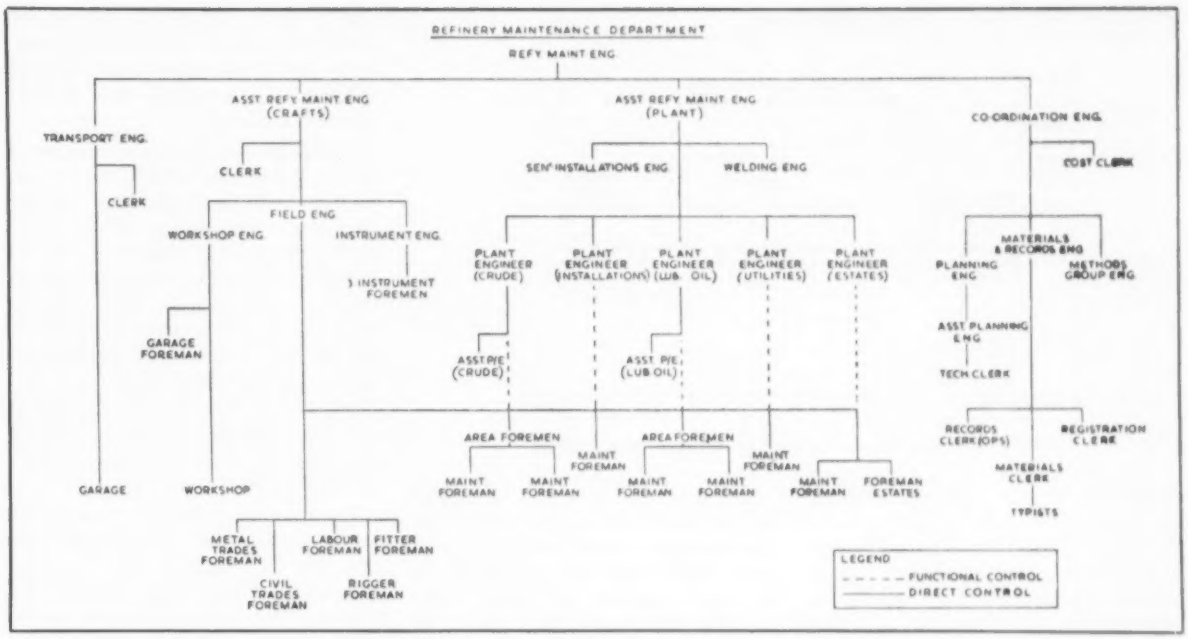



**FIGURE 2—Organization chart for refinery maintenance at Kent.**

for every job, a considerable amount of specialized job training is necessary and is proceeding in one form or another during a considerable part of the time. Examples of such instruction are training in methods of working on hazardous pursuits, participation in courses run by equipment manufacturers, and informal talks by craft foremen to chargehands on features of interest in any failures that take place.

**Who Does the Work?**—From the answers to the previous three questions the size of the total maintenance force is established in relation to the volume of work. The organization and allocation of this force is the key to its effectiveness, and will be examined in some detail. Figure 2 indicates the system diagrammatically.

There are three main functional divisions, plant engineering, crafts group and planning.

The Plant Engineering group is that in which the main body of technical knowledge is vested. This group is responsible for sound engineering and execution of maintenance in an economical manner. They are required to coordinate work with process control in order to minimize interference with production.

The Crafts group furnishes the manual skill and the "know how" regarding tools and equipment. They are responsible for job discipline, and job methods and they direct the execution of work in the workshops and field to the over-all requirements of the Plant Engineering group.

The Coordination group provides service to both parties in the following fields: (a) Cost analysis and indication of trends to assist in controlling expenditures; (b) establishment of common policies of procedures in respect to materials and liaison with Stores department; (c) planning and progressing of long-term and major works, estimating and forecasting manpower requirements to meet departmental commitments; (d) plant records and technical data; (e) all office services; (f) technical assistance to Plant Engineering group on matters common to all areas of the refinery; (g) technical assistance to Crafts group in respect to maintenance methods, tooling equipment facilities, etc., necessary to increase productivity.

For maintenance purposes the refinery is divided into five areas. The basis of this division in four instances is the type of operation, and the fifth covers non-operating general facilities, i.e., offices, roads, company housing estate, etc. This system was chosen so as to establish the process supervisor-engineer relationship which is essential if maintenance is to act as a service to production and execute works to suit the production program.

Each area is headed by a plant engineer who has over-all responsibility for that area and there are several assistant plant engineers who may be attached to areas as the work load demands. Second to each area from the crafts group is an area maintenance foreman who is responsible for the field supervision of all the work carried out in the area. It must be borne in mind that craft division, as a whole, is working to the over-all directions of the plant engineering group. The area foreman is the craft division representative for each area, the link between the two functions at area level.

The diagram in Figure 2 will help clarify the system, and Table 1 sets out the division of responsibilities. In addition to workshops and an extremely specialized group such as the Instrument Section, there are five main craft groups, each headed by a craft foreman. For reasons peculiar to this type of work we have combined certain trades, e.g., pipe fitters, boilermakers, etc. These craft foremen are responsible for the work in their trade, for job methods, trade training, tooling, job discipline and individual worker performance.

Each craft foreman has several chargehands, the number being in

KENT OIL REFINERY LTD
Request For Maintenance Service
Ser. No. 1146

Requested by D.W. Jaques Dept. Maintenance Date 25.3.55.
Location of job N.E.K. Dewaxing Unit.
Identification No.9 Filter W.I.N. 4671-0010 Site No. F9
Wanted Immediate Permits Req'd Availability Upon request By arrangement
Complete by 1.4.55.

Particulars of Work required

Blank off No.9 Filter. Remove hood, strip cloth, examine screens and re-cloth. Carry out provisions of Routine Service Specification M33 at same time.

For Maint. Dept. use Work Order No. 1428 M

**FIGURE 3—Typical request for work by maintenance department.**

proportion to the labor strength of the trade. The craft foreman assigns the men of their crafts to each area in accordance with the labor allocation determined by the Plant Engineering group from the over-all refinery work load. The essential feature to note is that the craft foreman is responsible for the worker and the area foreman is responsible for the work.

Now consider the manner in which work is executed from the inception of a job to completion. All requests for maintenance work must be submitted in writing. They may emanate from within the Maintenance Department due to (1) the preventive maintenance scheme; (2) the corrective maintenance scheme; or (3) the plant shutdown system. They may also arise from requirements of the operating department or from recommendations for modifications or additions to plant which involve capital expenditure, each separately approved by the management. All work requests are submitted on Form RE.15 (Figure 3).

It is essential that work requests be thus registered on paper, since without this it is impossible to exercise control over the volume of work. All work requests pass through the plant engineer and if approved by him he turns a request into a suitable directive for the execution of engineering work. He has drawings or sketches made, procures material, investigates process conditions, previous plant history and any other relevant factors. For example, an important factor is whether a piece of equipment is vital to a plant's operation, tied within a group or completely free to be isolated, and much investigation may be required to determine this in process plants. Once done, this information is recorded on the equipment record card and is available to the plant engineer for future reference. By this means most of the information required is made immediately available to the plant engineer on the equipment record card.

On the reverse side of the RE. 15 Form the plant engineer makes out job breakdown, enumerating the nature and sequence of operations, the crafts required and the man-hour estimate against each operation. This form then passes to the planning office who register it and give it a cost code number and translate the work request into a work order (Figure 3).

The work order is a typed copy of the completed RE. 15 Form. One copy is made out for each craft concerned in the job, so that each craft chargehand engaged on a job has clear written directions to work to. In the case illustrated, for example, there were carbon copies for the riggers, pipefitters, machine fitters, insulators and laborers. The entire group of documents, including drawings, material lists, safety permits, etc., are then returned to the plant engineer in one folder and are issued to the area foreman when the necessary arrangements have been made to execute the work involved without delay. If the job is a major one, the plant engineer obtains the services of the Coordination group for detailed planning, production of Cantt charts, etc.

On completion of the job the work order is returned by the area foreman via the plant engineer to the Coordination office. Records section extract relevant information and enter on the record equipment card and Statistics section can obtain job cost details from Accounting department and compare performance with estimate. The complete flow is illustrated in Figure 4.

The plant engineer thus amasses a definite work load which can be calculated from a summation of the man-hour breakdown. This falls partly into a certain sequence due to delivery dates for component materials, etc., and is partly determined by the relative priorities for work essential to the continuity of production operations. Priorities within and between the areas can be established and labor utilized to the maximum efficiency by allocation to suit management's production plan.

The total work load of the maintenance organization may broadly be split into five sections: (1) Plant inspection and servicing routine and housekeeping duties; (2) plant operations requiring craft services (e.g. blank swinging, special line connections, etc.). These are continuous demands of known magnitude; (3) major overhauls to be executed at times determined by production plan or by statute; (4) non-priority maintenance work, e.g. modifications and additions; (5) work requests (RE. 15's).

The load may be charted and the system of control established permits work to be planned and interposed in the valleys of activity to provide a steady load for an economic labor force (Figure 5). This chart provides Plant Engineering group with their guide in directing labor allocations within the total force available. Labor allocations are made by the senior plant engineer as follows: (a) A basic crew is seconded to each area on long term loan in accordance with the calculated work load of servicing duties, etc.; (b) supplementary weekly allocation is made from the pool to execute selected pre-engineered work covered by RE. 15's, overhauls, etc. This is done at a meeting attended by plant engineers, coordination engineer, craft superintendent and workshop engineer, under the chairmanship of the senior plant engineer. This allocation is reviewed daily and variations made, if required, to suit special conditions.

Following this plan, the Coordination office provides a weekly job schedule listing work to be executed, the labor involved, etc., and issues them to all concerned. The craft fore-

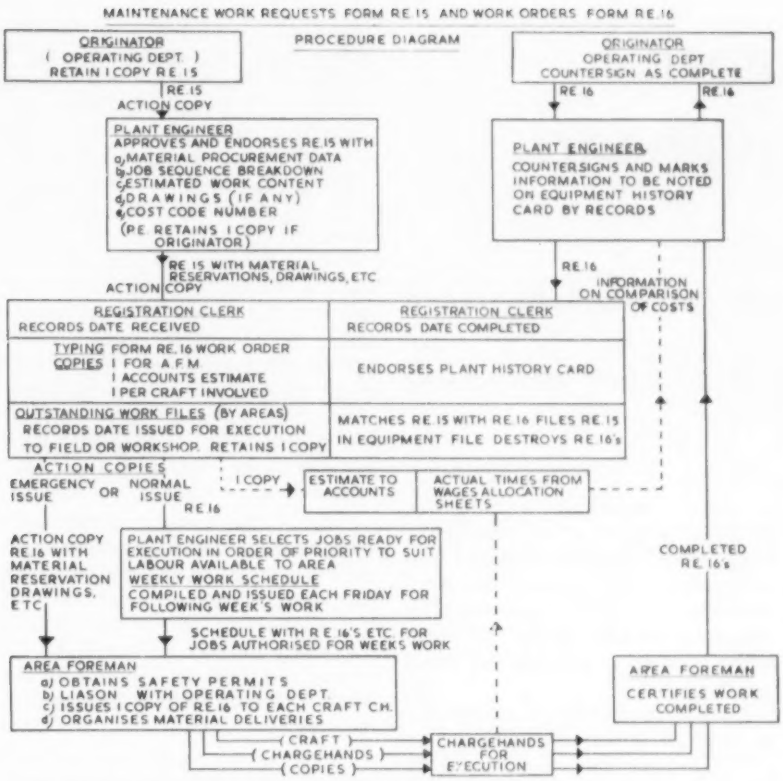



**FIGURE 4—Procedure chart for work requests and orders.**

men then assign their men to the areas in accordance with the weekly schedule, when appropriate men with special skills may be assigned to particular jobs. The area foreman directs the work of the allocated labor force on the specified jobs. Any variations are determined at a daily meeting, similar to the weekly meeting, and are communicated to all by minutes which constitute an order and the craft foremen act on this and modify the assignment of their men accordingly.

Each day, craftsmen assigned report to the area foreman for work. He tells them which job is to be done, gives the chargehand in each craft the relevant work order, coordinates material deliveries from stores to the job and gets the job started. The area foreman is responsible for seeing that the work can be done efficiently and safely. He makes all on-the-spot arrangements with process foremen, etc., for occupation and isolation of plant.

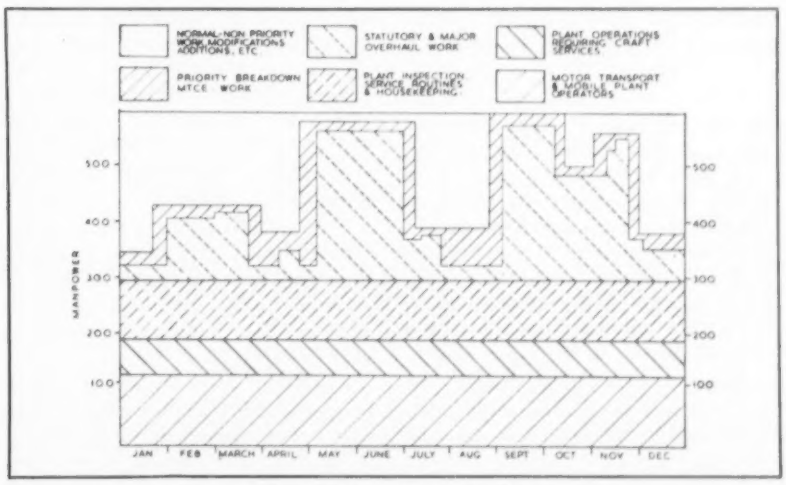



**FIGURE 5—Chart of annual workload.**

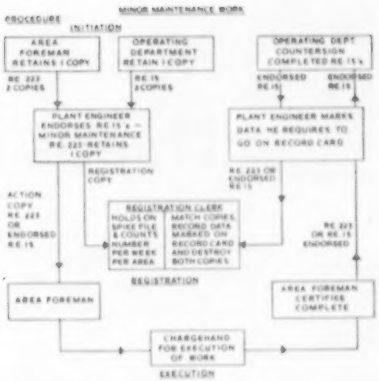

MINOR MAINTENANCE WORK
PROCEDURE
INITIATION
AREA FOREMAN RETAINS 1 COPY
OPERATING DEPARTMENT RETAIN 1 COPY
OPERATING DEPT COUNTERSIGN COMPLETED R.E.15's
R.E. 223 2 COPIES
R.E.15 2 COPIES
ENDORSED R.E.15
ENDORSED R.E.15
PLANT ENGINEER ENDORSES R.E.15's — MINOR MAINTENANCE R.E. 223 RETAINS 1 COPY
PLANT ENGINEER MARKS DATA HE REQUIRES TO GO ON RECORD CARD
REGISTRATION COPY
R.E. 223 OR ENDORSED R.E.15
ACTION COPY R.E. 223 OR ENDORSED R.E.15
REGISTRATION CLERK
HOLDS ON SPIKE FILE & COUNTS NUMBER PER WEEK PER AREA
MATCH COPIES, RECORD DATA MARKED ON RECORD CARD AND DESTROY BOTH COPIES
R.E. 223 OR R.E.15 ENDORSED
REGISTRATION
AREA FOREMAN
AREA FOREMAN CERTIFIES COMPLETE
CHARGEHAND FOR EXECUTION OF WORK
EXECUTION

**FIGURE 6—Procedure chart for minor maintenance work.**

Perhaps the most controversial point about this form of organization is the arrangement of craft foremen and area foremen and the division of craft functions into the work and the worker. The two are complementary. Each has distinct and separate but parallel responsibilities. Once this is established and a spirit of cooperation between the two groups is achieved, the benefits are great. The worker soon realizes that he is not working for two bosses, but has two men to help him in specific aspects of his work.

This arrangement has resulted in more efficient coordination and supervision of the small jobs which comprise about 60 percent of the annual work load.

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**MAINTENANCE**

# Maintenance Needs Engineers

## MEMO TO INDUSTRY:

**• Recognize the need for technically trained men.**

**• Show the young engineer how maintenance work can help him get ahead.**

**L. J. Cormack,** New Orleans

THE YOUNG engineer who balks at starting out in a mechanical or maintenance department is passing up a chance for excellent managerial development. In some instances he may be throwing fast promotions out the window.

Why do engineers cast a wary eye on maintenance work? There are two reasons:

• Failure of top management to recognize the need for—and importance of—technically trained personnel in maintenance work.

• Failure of engineers to foresee the vast potential of this field.

Although many companies do not yet utilize engineers as supervisors in repair of equipment and plant maintenance, steps are now being taken to transfer technically trained personnel into this field. Companies are learning that this is a money making proposition and the benefits are many.

Following are examples which illustrate the need for—and importance of—technically trained maintenance men:

1. Among newer installations you may find a completely integrated plant which consists of several units. The over-all investment runs into the millions. An unscheduled outage or shutdown of a continuous process department or shutdown of a continuous process plant presents a definite monetary loss to make repairs. It also upsets shipping schedules and the meeting of sales commitments.

2. As instrumentation progresses, the number of operators are reduced, thus the ratio of maintenance cost to total cost increases. Production hinges on these instruments keeping the processes controlled to very close limits. They must be inspected and maintained. This requires technical knowhow plus field experience. An intimate knowledge of the equipment is also required to schedule inspection and overhaul.

3. With the increase in complexity of modern plants, knowledge required to supervise repairs demands that a man have an above average understanding of the field. Scheduling and planning to utilize available manpower, and at the same time keep shutdowns to a minimum, requires knowledge of the process as well as the equipment.

4. Technically trained men are needed to cope with the problems of maintaining present day operating equipment. In many plants process temperatures vary from minus 200 F. to 2000 F. In the same plant there may be pressures exceeding 5000 pounds per square inch. Even in these medium size process plants a large variety of mechanical equipment is encountered.

5. Warehouses, spare parts and operating supplies are major cost factors in a modern plant. An engineer with field experience is needed to handle the spare parts required to provide maximum coverage with a minimum amount of money tied up in stock. Supply handling also requires an intimate knowledge of plant equipment, operating conditions and the past history of the equipment.

These five examples justify the need for technically trained maintenance men. Now, what does this field offer the engineer?

Engineers who have gone to work in mechanical and maintenance departments have found that their degree was just the beginning—that it was an admission ticket to a show as varied as a three-ring circus. Not only have they had to keep in step with the latest developments in this field, they have had to acquire knowledge of other phases of engineering as well.

Having been in the field, these engineers learned to make decisions quickly. They used their judgment and experience many times over in taking calculated risks to return units to production without excess downtime. They have prepared budgets and estimates of work, thus have learned to be cost-conscious in accomplishing their job.

One of the greatest assets aside from their technical development is the experience maintenance engineers gain in supervising people. They have learned that no one is perfect and the ability to work effectively by directing the efforts of others is an art which can only be acquired by experience.

Maintenance engineers have developed themselves proficiently in their chosen field—broadened their vision in engineering—and have acquired excellent supervisory and administrative experience. In many cases they are very well versed in the operation of plant equipment.

What better background could a company desire from a top management employe?

Contrast this with the engineer who has stayed in engineering. He can progress to his position of senior engineer with the label of a specialist. He will probably know little of the other fields of engineering since his work comprises only one small field of endeavor. He may have a few employes under his supervision, but his experience in working with and through people is very inferior to the engineer who has been in the maintenance department.

The engineer of today has a harder task. He must have technical knowledge and be well versed in human relations. Ability to handle people is as important as technical knowhow in the modern plant.

The young engineer who overlooks the possibilities of working in mechanical or maintenance departments is missing an excellent chance for advancement to the top. ##

FIGURE 1—Improper packing procedure in a hot oil charge pump resulted in this example of excessive sleeve wear.

FIGURE 2—Extreme conditions of wear often found in pumps not periodically internally inspected. A new impeller is at the right.

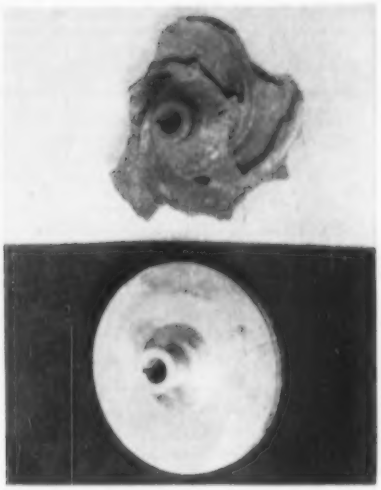

FIGURE 3—Here is the impeller removed from the pump (Figure 2), compared with a new one.

You can avoid this trouble with . . .

# Preventive Maintenance of Process Pumps

**Here are the results of comparative experience in pump maintenance methods and how costs were cut in half.**

**William M. Wise**
Sun Oil Company
Marcus Hook, Pa.

AN UNUSUAL opportunity to compare process pump maintenance methods occured at Sun Oil Company's Marcus Hook refinery. The plant has about 2000 pumps in service. Until recently there were five separate operating areas. Each of these areas had a different field maintenance practice. Lowest maintenance cost per unit was in Zone 3 (Figure 4). Pumps were given an annual "teardown" for preventive maintenance inspection and repair.

The pumps thruout the five areas were properly lubricated by "oilers" assigned to do the job. All pumps requiring shop repairs were sent to the

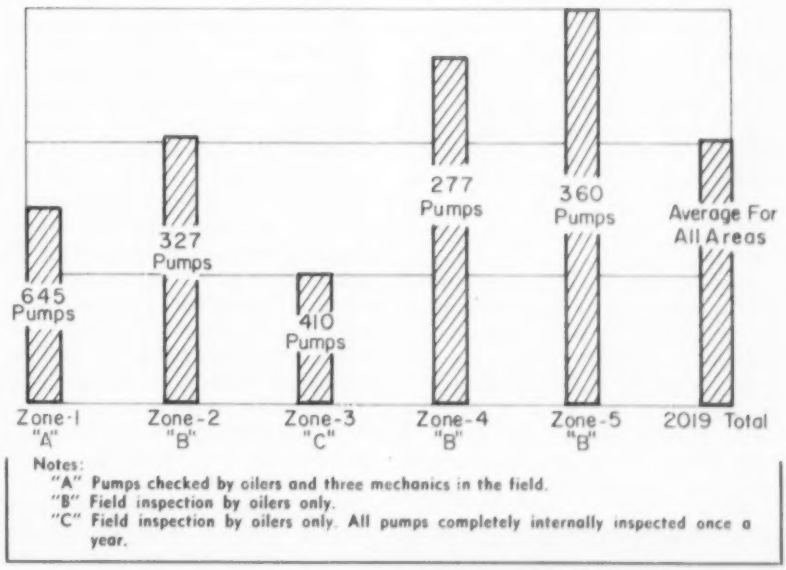


FIGURE 4—Comparison of average pump maintenance costs in the five areas.

REPORT OF WORK DONE ON A CENTRIFUGAL PUMP — SUN OIL PUMP NUMBER:

| PART | | O.K.'D | REP | NEW | REMARKS | GENERAL |
|---|---|---|---|---|---|---|
| CASING | | | | | | Pump Make: |
| IMPELLERS | 1st Stg. | | | | O.D. (Inches) | Size & Type: |
| | 2nd Stg. | | | | O.D. " | Location: |
| | 3rd Stg. | | | | O.D. " | Service: |
| | 4th Stg. | | | | O.D. " | W.O. No. |
| SHAFT | | | | | | Date / Shift / Mechanic |
| WEARING RINGS | Impeller | | | | | |
| | Case | | | | | |
| SHAFT SLEEVES | Coupling | | | | | |
| | Outboard | | | | | Foremen: |
| BEARINGS | Coupling | | | | Mfr. & No. | |
| | Outboard | | | | | |
| | | | | | | General Notes: |
| STUFFING BOX BUSH. | Coupling | | | | | |
| | Outboard | | | | | |
| OIL SEALS | Coupling | | | | Mfr. & No. | |
| | Outboard | | | | | |
| COUPLING | Flex.Part | | | | Mfr. & Size | |
| | Other | | | | | |
| PACKING | | | | | Mfr. Size | |
| | | | | | Type No. Rings: | |
| | | | | | Type No. Rings: | |
| MECHANICAL SHAFT SEAL | Gland | | | | | |
| | Stat.Face | | | | | |
| | Packing | | | | | |
| | Rot. Face | | | | | In Field - |
| | Packing | | | | | In Mach. Shop - |
| | Springs | | | | | Total Hours - |

| CLEARANCES (DIAMETRAL) (INCHES) | | Wear Ring O.B. 1 Stg. | Wear Ring I.B. 1 Stg. | Wear Ring 2nd Stg. | Wear Ring 3rd Stg. | Wear Ring 4th Stg. | | Throat Bushing Opp. End | Throat Bushing O.B. End | |
|---|---|---|---|---|---|---|---|---|---|---|
| | As Is | | | | | | | | | |
| | After Repairs | | | | | | | | | |

**FIGURE 5—Centrifugal pump work report form used to record performance history.**

shop and the same standards of workmanship were used. The services of the Mechanical Technical group were not confined to any one area but were uniform for all refinery pumps. With one exception, Zone 5, in which there is an Alkylation plant using hydrofluoric acid, the pumps in the various areas handle similar materials and liquids under comparable conditions. Thus, our only explanation for the lower yearly maintenance cost of the Zone 3 pumps is that the annual preventive maintenance inspection pays off.

In this inspection the pump is thoroughly examined in the following respects: erosion of body, cavitation of impellers, clearance of case and impeller rings, fit of ball races in the casing and on the shaft, gasket surfaces, packing gland bolts, head or joint bolts, threads on plugs, sample and gage connections, and pipe strains.

In Zone 1, with the next lowest cost per pump, three first-class machinists were used on a full-time basis as pump inspectors. The 645 pumps were divided into three groups and each pump was inspected frequently by one of the machinist inspectors.

This inspection included checking the pumps for vibration, lubrication of bearings and couplings, condensate in bearing housings, condition of cooling water jackets and lines, condition of piston rods, condition of packing and sleeves, etc.

In addition to the mechanical inspection, the machinists also kept a close check on the performance of the pumping equipment. Operators were frequently consulted. Pressure gage and meter readings were observed for indications that a pump was not operating efficiently.

Anything observed by the inspectors indicating that repairs were required was reported to a mechanical foreman. The necessary work was done.

If no reports were received on a pump in this area, from either the inspectors or the operators, it was run to failure.

In addition to inspection work, the three machinists repacked or tightened packing on all pumps assigned to them. They made any other minor repairs or adjustments as required.

These men did an excellent job in uncovering most mechanical defects and in correcting the small ones. This area was expected to have the lowest unit of maintenance cost per pump since the inspectors made small immediate repairs or adjustments which saved many a major job from developing. The only reason that the costs were not the lowest is that the men could not see inside the pump. This is where the most costly mechanical faults develop.

In the other three areas, the only special attention the pumps received was from the oilers assigned to lubricate them. Any conditions requiring repairs, reported by the operators, mechanical foremen, or oilers were corrected. No special personnel checked on the pumping equipment. On major unit shutdowns, pumps were overhauled and internally inspected.

This was done only when there were indications of mechanical faults or inadequate performance.

As shown by Figure 4, this system resulted in relatively high maintenance costs.

There are many justifications, besides maintenance cost, for periodic internal inspection of pumping equipment. Pumps can be scheduled for an inspection at a time most suitable to the Operating department. If pumps are run to failure, the breakdowns always seem to occur at times most inconvenient to both Operating and Mechanical departments. Often this causes throughput loss and overtime labor for repairs.

Safety and fire prevention are everyone's concerns. Pumps running in poor mechanical condition can be hazardous. All refineries have experienced fires due to packing failures, stuffing box and gland failures, leaks from plugs, and gage nipples. Any program that reduces the frequency of these occurrences is obviously worth a great deal.

The morale of the foremen and the men is of primary concern. A preventive program that lets the mechanics work a greater percentage of their time on scheduled repairs and less time on emergencies is a morale booster. The men feel that they are controlling and running the equipment, rather than letting it run them.

Reduction of maintenance storehouse inventories of pump parts also depends greatly on the effectiveness of the preventive program. If repairs can be kept to a minimum, packing standardized, and the materials used in the various pump parts constantly checked to make sure they are best for their particular service, purchase and storage of spare and repair parts can be reduced.

The policy of giving every pump in severe service an annual internal inspection has proven satisfactory. But this may not be the final answer. Through the use and anlysis of the pump reports (Figure 5) it is hoped to establish a better schedule for inspection of each pump. The schedule will establish the most desirable program for tearing down the pump, replacing the packing or checking the mechanical seals, checking alignment of pump and driver and inspecting the bearings.

For a thorough preventive program, close cooperation between the field, shop, and mechanical technical groups is required. Each group has to perform its assigned work properly and also make full use of the experience and knowledge possessed by the members of the other groups.

Let us list some of the groups' problems.

The greatest problem within the field group is to maintain proper standards of workmanship and to develop proper work procedures. An example of the results of poor packing procedures is shown in the damaged pump sleeve in Figure 1.

The selection of packing and lubrication for each individual pump must be made by the technical group. To reduce costs, it is necessary to select the most suitable packing or lubrication with much thought and effort being given to standardization. It is practice to use as few types of packing and lubrication as practical. In this way storehouse inventories can be kept to a minimum and the possibilities of mistakes are reduced.

Pumps in which the packing causes problems such as excessive leakage and unusual wearing of sleeves, are referred to the Mechanical Technical group for study. Their approved recommendations to correct the specific conditions, which can range from a simple change of packing to the installation of a mechanical seal, are then followed in the shop and the field.

During shop overhaul, pumps are inspected with the thought of making any changes in materials or design that might be desirable to increase their useful life or efficiency. All changes of this type are referred to the technical group. No changes are made until they have obtained the proper approvals.

Refinery processing is subject to frequent changes. A pump purchased for a given flow and head with certain fluid may be placed in an entirely different service with different operating requirements. Another phase of worthwhile preventive maintenance is having the technical group thoroughly check such proposed changes. This includes the metallurgy of the pump and the efficiency required in the revised service. Often it may be necessary to reduce the diameter of the impeller. Then an available driver will have sufficient horsepower. The cost of the necessary changes may be so great that it would pay to buy another pump designed for the new service.

To summarize our practices for preventive maintenance of pumps, the following procedures are important:

**1.** Establish a schedule for inspection of all pumps, including internal inspection.

Any schedule is naturally based on the most economical period and has to be worked out for each individual pump as the required information is developed. Until experience proves otherwise, each pump is internally inspected annually.

**2.** Keep a complete record of repairs. Proper analysis of these records will form a basis for preventive maintenance, which will reduce the frequency and cost of the work.

For example, the inspection reports might show that a certain pump requires an abnormal number of bearing replacements. This could be an indication that misalignment exists that requires correction. With adequate records the foremen become aware of conditions of this type as soon as they occur.

When the records on a given pump become sufficiently complete they are studied and the most economical inspection timetable is determined.

**3.** Obtain good communications and close contact between the shop, field and technical groups. Each group must do its part and successful preventive maintenance requires the combined contributions of all three groups. ##

## Meet the Author

WILLIAM M. WISE is general foreman in the Mechanical department at Sun Oil Company's Marcus Hook, Pa., refinery. Assigned to that department for some 17 years, he has held a number of engineering and supervisory positions. In his present position, Wise has supervision over some 330 mechanics and foremen. His background also includes three years of design engineering with a large chemical concern. He is a mechanical-engineering graduate from the University of Pennsylvania.

$ MAINTENANCE

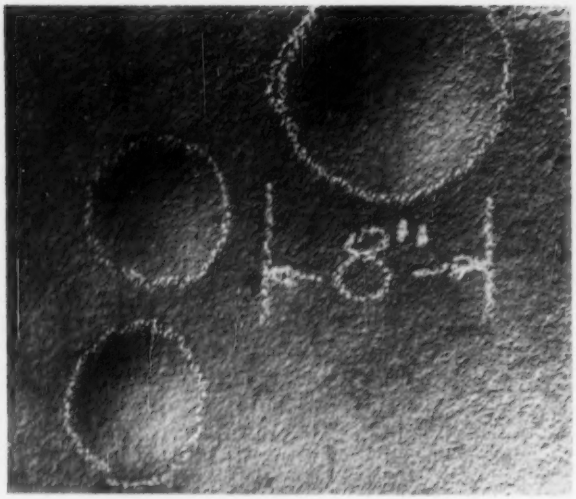

FIGURE 1—Typical hydrogen blister inside a debutanizer accumulator drum.

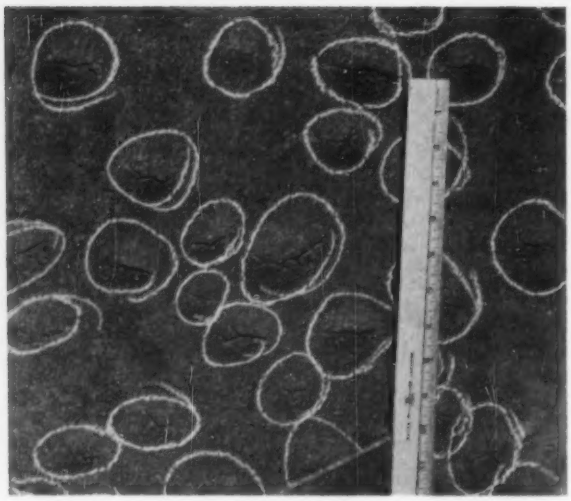

FIGURE 2—Typical split hydrogen blister inside a depentanizer reflux drum.

# How to Reduce Hydrogen Attack

**Here are the results of six years in minimizing $H_2$ attack.**

**Gordon R. King**
Humble Oil & Refining Company
Baytown, Texas

THE BIG QUESTION in any discussion of hydrogen damage is, "What can be done to prevent such attack?" Fundamentally the answer is simple; eliminate the source of hydrogen. The actual performance of this task, however, becomes complex.

The experience and data of hydrogen attack and countermeasures to this attack contained here were compiled in the past six years. In this period, hydrogen attack in the oil industry has grown from infancy to a problem of major magnitude. This situation has arisen as a result of the catalytic cracking of heavier feed stocks which inherently produces more nitrogen compounds; hence, ammonium cyanide, an accelerator to hydrogen penetration. Examples of hydrogen blistering of steel vessel walls are shown in Figures 1, 2 and 3.

It has been well established that

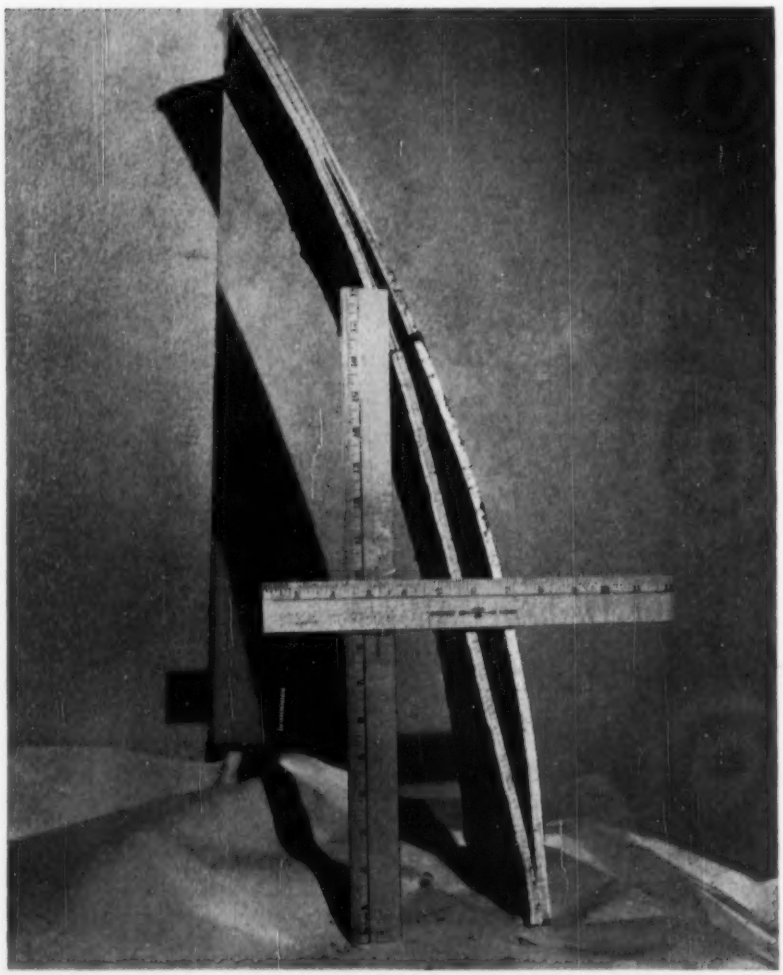

FIGURE 3—Massive hydrogen blister in shell of a rich oil drum.

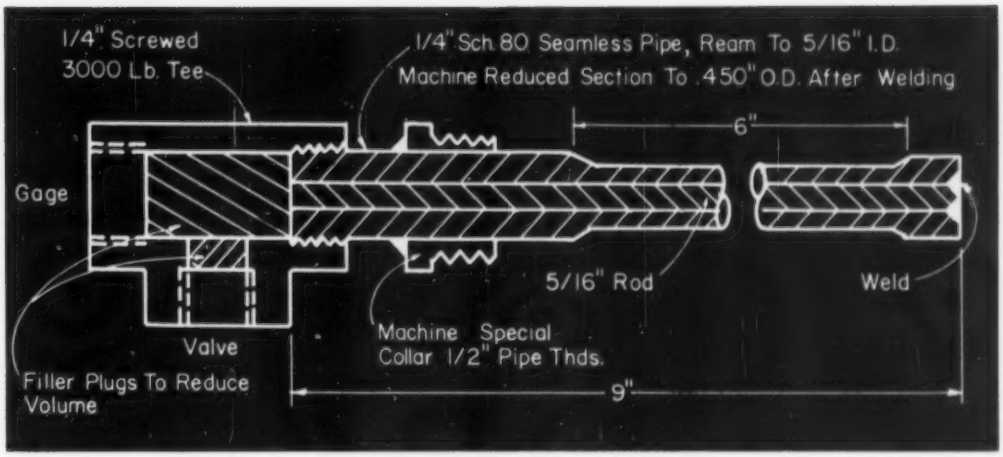


**FIGURE 4—Details of a low pressure hydrogen penetration probe.**

this damaging hydrogen must first be in the atomic form, then under certain conditions change to molecular hydrogen or some compound. This atomic hydrogen can originate from: (1) the liberation of atomic hydrogen as a product of a desired hydrocarbon conversion.

Usually the operating demands preclude any appreciable change in this condition. (2) The chemical action (or corrosion) of a metal by a certain compound, resulting in the formation of a metal salt and the release of nascent hydrogen. Potential damage from this latter source of hydrogen can be combatted in two general ways or in a combination of these methods:

- Protective liners.
- Alteration of the corrosive medium.

**Protective Liners**—Perhaps the most common type protective liner in use is concrete, usually consisting of portland cement and sand in a 1:3 ratio, applied over ¼-inch reinforcing rods (welded in place) and 3-inch x 3-inch x 10 gage wire mesh (wired to the rods). This type liner is economical to install and offers good protection for a relatively short period of time. It is limited, however, to mediums with a pH above 5. Surfaces in more acidic streams should be protected by other means.

An alloy metal strip lining costs approximately 5 times as much to install in a vessel as does concrete, however, it provides a more or less permanent type liner. The material chosen should depend upon the pH and other characteristics of the stream, however, one of the following materials will suffice for practically all applications: 12 percent chrome (AISI type 410), 18-8 chrome-nickel (AISI type 304 or 316), or monel (70 percent nickel, 30 percent copper, ASTM Spec. B-127).

The liner; 10 to 16 gage in thickness, should be applied in 6 to 8-inch wide strips, depending upon the curvature of the vessel, and should be welded with an equally corrosion-resistant rod, both to the shell of the vessel and to the adjacent strip. The choice of lining material has a relatively small effect on the cost of such an installation, inasmuch as the labor involved amounts to approximately 90 percent of the total expenditure.

In some instances steel liners have been installed in large sections, which reduces the installation costs over that for 6-inch wide alloy strip lining. The purpose of these steel liners is to take the brunt of the corrosion in place of the vessel shell.

A small hole should be drilled in each separate plate of the liner to allow the escape of molecular hydrogen which forms back of the liner. This method is only partially effective for it has been shown that atomic hydrogen at high temperature can pass through one void, through a thickness of steel, and into another void before forming molecular hydrogen.

Several neoprene-type rubbers and plastics are now available for commercial lining of vessels. Their effectiveness and economic value have not been well proven as yet. The main disadvantage of this type liner is that its bond to the vessel wall is dependent upon a smooth surface, which limits its use to new vessels.

A large number of chemical inhibitors are now commercially available. This method of protection is included in the section on protective liners, for that is exactly what the majority of chemical inhibitors are; they form a protective film over the internal surface of the equipment, acting as a barrier between the corrosive medium and the shell.

They are very effective in certain applications, economical, and have the advantage of covering otherwise inaccessible portions of the system. The disadvantages lie in the time lag between the initial injection of the inhibitor and the acquiring of protection throughout the system.

This may take as long as 30 to 60 days. When a unit is removed from service and cleaned for internal work a large portion of the protective film is destroyed and must be re-established.

**Alteration of the Corrosive Medium**—Practically all refineries are plagued with the necessity of charging sour crude. That is, crude containing varying amounts of sulfur compounds, which are carried through practically all process units. This results in a general problem of corrosion and hydrogen attack. The question is asked, Why not remove all these sulfur compounds from the crude before it is charged in the refinery? It could be done, but the units required for the desulfurization of say, 70,000 barrels of oil per day would be quite large

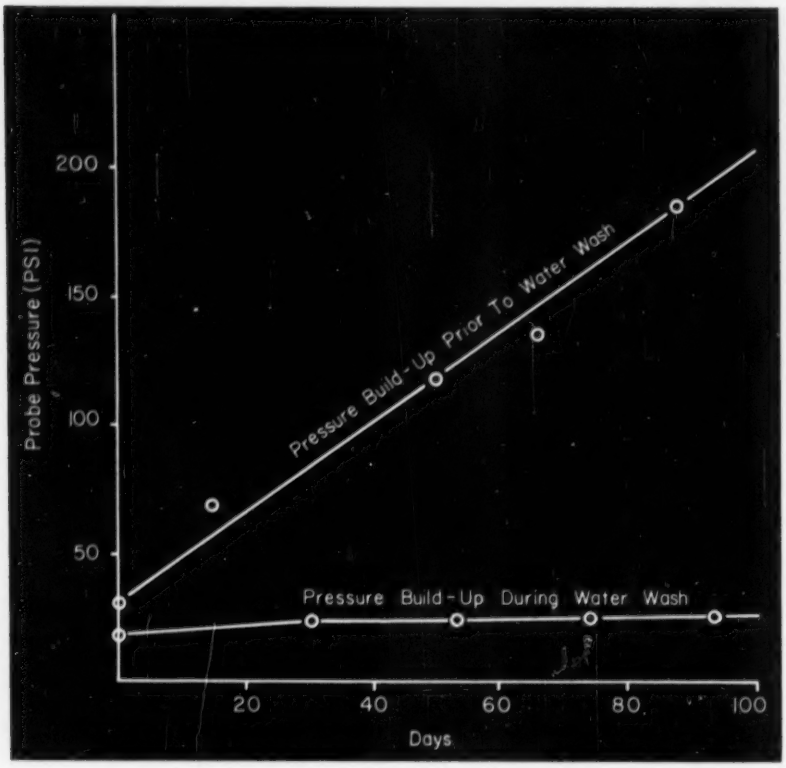


**FIGURE 5—Plot of probe pressure while installed in vapor phase of depentanizer reflux drum.**

and would entail a capital investment of several million dollars. This problem has been analyzed, but to date such an expenditure does not appear justifiable.

**Dehydration**—Dry hydrogen sulfide is relatively non-corrosive at moderate temperatures. If all moisture could be removed from the oil streams, corrosion would be at a minimum. All crude oil contains some water and leakage of cooling water into oil streams occurs throughout the refinery. Dehydration, then, becomes a problem of similar magnitude of desulfurization.

**Water Washing**—In the early part of 1952 hydrogen attack had become so severe at Humble Oil & Refining Company's Catalytic Light Ends Unit No. 1 (CLEU No. 1), that an estimated $365,000 per year was being lost by way of equipment deterioration and the associated process debit for unit downtimes. Protective liners were not practical because of the large areas involved, inaccessibility of some areas (pump cases and piping), and clearances (exchanger shells).

Desulfurization and dehydration were impractical because of initial cost and construction time. The answer was in the removal of the cyanide compounds which are accelerators to hydrogen attack. These cyanides originated from the synthesis of nitrogenous compounds resulting from the catalytic cracking of heavy feed stocks.

Since cyanide compounds are generally soluble in water, plans were undertaken to water wash the gas streams from Fluid Catalytic Cracking Unit Nos. 1 and 2 (FCCU Nos. 1 and 2). Tests indicated that these gas streams contained in excess of 80 percent of the cyanides produced.

Water wash facilities were designed for FCCU Nos. 1 and 2 on the basis of six gallons per minute of water per million standard cubic feet per stream day of catalytic gas produced. These facilities at each unit consisted of a pump for the injection of well water downstream of the compressor, a disengaging drum for the hydrocarbons and water, a sour water gathering system, and a stripping tower for the removal of entrained hydrogen sulfide so the wash water could be disposed of in the sewer system.

Following is a tabulation of the hydrogen activity, countermeasures undertaken, and the results of such steps:

1. Prior to water washing—Low pressure steel hydrogen penetration probes (see Figure 4) were installed in the vapor stage test pot on depentanizer reflux drum, F-16 at CLEU No. 1, the water draw-off pot on F-16 drum, and the water-draw off pot on depropanizer reflux drum, F-18 at CLEU No. 1. The volume and surface area of the probes were measured so that pressure readings could be converted to a "volume of hydrogen penetrated per area per day" basis. Water samples were taken periodically from F-16 and F-18 for the determination of pH, cyanide, and sulfide concentrations. Figure 5 shows a curve of the hydrogen pressure build-up versus time of a probe in F-16 vapor phase test pot. Following is some data obtained from F-16 and F-18 water draw-off pots:

| | F-16 Water Draw-off Pot | F-18 Water Draw-off Pot |
|---|---|---|
| Hydrogen penetration cc/sq ft/day | 200 | 600 |
| pH | 7.8 | 7.4 |
| Cyanide concentration parts/million | 600 | 1,500 |
| Sulfide concentration parts/million | 15,000 | 20,000 |

2. Water washing at capacity of system—The original water wash systems were designed for a total of 300 gpm; 200 gpm of which was to be injected at FCCU No. 2 and 100 gpm at FCCU No. 1.

A water injection rate of 200 gpm was attained at FCCU No. 2, which amounted to approximately 17,000 gallons per million cubic feet of catalytic gas produced. The result was the removal of approximately 140 pounds per day of cyanides, which represented 75 percent of total cyanides produced at this unit. Approximately 2000 pounds per day of hydrogen sulfide was also removed.

Because of inadequate water settling capacity downstream of the wash system, only 40 gpm of wash water (4100 gallons per million cubic feet gas) could be injected at FCCU No. 1, which was effective in removing approximately 25 percent of the total cyanides produced at this unit.

Water washing was continued for approximately one year, during which time very little probe activity was observed (note curve in Figure 5). Fol-

lowing is some data for a period of total water washing at the rate 165 gpm:

| | F-16 Water Draw-off Pot | F-18 Water Draw-off Pot |
|---|---|---|
| Hydrogen penetration cc/sq ft/day | 0 | 0 |
| pH | 6.8 | 6.5 |
| Cyanide concentration, ppm | 366 | 900 |

Visual inspections of CLEU No. 1 during this interval of water washing indicated a general reduction in hydrogen attack; however, the deterioration continued unabated in a few locations and appeared in some areas that were previously unaffected. It was apparent that some improvement or better countermeasure would have to be initiated.

**Air Injection**—The inhibiting effect of ammonia polysulfide compounds to hydrogen sulfide corrosion and hence the penetration of hydrogen is well established. The polysulfides form a protective film over metal surfaces, but this film apparently is not a hard impervious scale formed as a product of a reaction with the surface, as in the case of iron sulfide. The polysulfide is formed independently of the surface and adheres to the surface by a direct adsorption process.

Cyanide compounds will scavenge a polysulfide film much in the same manner as they remove iron sulfide deposits. The reaction between cyanides and polysulfides results in an inactive, non-damaging, ammonium thiocyanate. One method of polysulfide inhibiting a cyanide containing stream against hydrogen penetration is to provide sufficient quantities of polysulfides to react with all the cyanide, and to provide an excess amount of polysulfides to form the protective film against hydrogen sulfide corrosion.

Polysulfides are ineffective at a pH of less than 7.5[8]. The injection of ammonia dissolved in water may be employed to maintain a pH above 7.5.

The next problem was obtaining sufficient quantities of these polysulfides. They could have been premixed and pumped into the system, but since large quantities of $H_2S$ and ammonia were present in the stream, a much more simple method of obtaining polysulfides was by the injection of controlled amounts of air.

The following reactions are thought to occur:

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1. Ammonia + hydrogen sulfide → ammonium hydrosulfide

$$NH_3 + H_2S \rightarrow NH_4HS$$

2. Ammonium hydrosulfide + oxygen → ammonium disulfide + water

$$4\,NH_4HS + O_2 \rightarrow 2\,(NH_4)_2S_2 + H_2O$$

or

Ammonium hydrosulfide + free sulfur → ammonium polysulfide + hydrogen sulfide

$$2\,NH_4HS + (X\text{-}1)S \rightarrow (NH_4)_2S_x + H_2S$$

The free sulfur in the last reaction can originate in either the oxidation of hydrogen sulfide or ammonium hydrosulfide.

3. Ammonium polysulfide + ammonium cyanide → ammonium sulfide + ammonium thiocyanate

$$(NH_4)_2S_x + NH_4CN \rightarrow (NH_4)S + NH_4CNS$$

These reactions have two main desirable effects: (1) The cyanide compounds which are promoters or accelerators to the hydrogen penetration phenomenon are converted into inactive thiocyanates. (2) The excess polysulfides act as inhibitors to further attack; i.e., they form a protective film over the surface. Ammonium hydrosulfide and oxygen in excess of that required for total reaction with all cyanides should be supplied for this second effect.

A time element is necessary for the complete conversion of all cyanides to thiocyanates; however, good protection has been experienced with a considerable amount of cyanides still present. This indicates the "protective film" role of polysulfides is somewhat more important than originally thought.

The air injection facilities installed consisted of a 20 cfm capacity air compressor each at FCCU Nos. 1 and 2. The injection point at each unit was the overhead vapor line from the prefractionator tower. Separate air compressors were used instead of the plant air system to preclude any possibility of hydrocarbons backing into the plant air system.

**Air Injection-Water Wash Combination**—Air injection was initiated with the water washing system still in operation. The water washing was gradually reduced and finally stopped altogether. Following are some results during this test period:

| | F-16 Water Draw-off Pot | F-18 Water Draw-off Pot |
|---|---|---|
| **Air Rate**—20 scfm (10 scfm each at FCCU Nos. 1 and 2). **Water Rate**—170 gpm (total). | | |
| Hydrogen penetration cc/sq ft/day | 0 | 0 |
| pH | 6.5 | 6.2 |
| Cyanide concentration, ppm | 372 | 874 |
| **Air Rate**—20 scfm **Water Rate**—100 gpm (total) | | |
| Hydrogen, cc/sq ft/day | 0 | 0 |
| pH | 7.0 | 6.4 |
| Cyanide, ppm | 390 | 780 |
| **Air Rate**—20 scfm **Water Rate**—none | | |
| Hydrogen, cc/sq ft/day | 0 | 0 |
| pH | 7.8 | 7.37 |
| Cyanide, ppm | 638 | 1600 |

Note how the cyanide concentration increased when all water wash was discontinued. No appreciable probe activity was in evidence at CLEU No. 1; however, the probes in Depropanizer Reflux Drum, D-3 at CLEU No. 2 indicated a hydrogen penetration of 354 cc per square foot per day. Steps were promptly taken to provide air at this unit. A compressor was installed and 4 cubic feet per minute of air was injected. The air rate at FCCU No. 2 was increased to 30 cfm. The probe activity then dropped to a negligible amount; however, the cyanide concentration was high, indicating incomplete conversion of this promoter.

Admiralty brass exchanger tubes which had been in service approximately six months in Depropanizer overhead condenser service at CLEU

No. 2 began showing severe deterioration. These tube bundles had steel baffles and brass tubes. The major deterioration took the form of galvanic action on the tubes adjacent the steel baffles. At the outset this seems strange; however, laboratory tests indicated a reversal in galvanic potentional between brass and steel in the presence of certain mixtures of cyanides and hydrogen sulfide, resulting in the brass becoming the anode or the corroding part of the galvanic cell.

Several combinations of air injection and water wash systems were explored at the Humble refinery. The present system has been in operation for approximately a year and has given excellent results. Briefly it consists of the following:

**Fluid Catalytic Cracking Unit No. 1**

Air Rate: 20 cfm into the overhead vapor line of the fractionator tower.

Water Rate: 40 gpm recycle water from the fractionator overhead condenser accumulator. This represents approximately 3000 gallons of water per million cubic feet of catalytic gas produced.

**Fluid Catalytic Cracking Unit No. 2**

Air Rate: 10 cfm into the overhead vapor line of the fractionator tower.

Water Rate: 40 gpm recycle water from the fractionator overhead condenser accumulator.

40 gpm recycle water from compressor interstage and after-stage knock-out drums. This 80 gpm of water represents approximately 5000 gallons of water per million cubic feet of catalytic gas produced. Approximately 40 gpm of heavily cyanide laden recycle water is drawn off the system at this point which reduces the total cyanide content at CLEU Nos. 1 and 2.

In the early days of water washing, fresh water was used on a once thru basis and was then discarded. Since time is an important element in the formation of these inhibiting polysulfides, it was found that by recycling the wash water, polysulfide concentrations could be greatly increased. In addition, this recycle water is high in pH which is very important in the formation and stability of polysulfide compounds.

In the past year of operation, hydrogen penetration probes installed at both Catalytic Light Ends Unit Nos. 1 and 2 indicated essentially no hydrogen activity. In addition, cyanide concentrations have been considerably below 900 ppm, the point which experience at the Humble refinery has shown to be the maximum allowable for negligible hydrogen attack.

Actual inspections of the internals of both CLEU Nos. 1 and 2 have revealed negligible hydrogen attack in areas which were previously severely damaged. Because of this reduced attack CLEU No. 1 was able to make an all-time record length process run.

In order to combat the galvanic corrosion of brass condenser tubes previously described, approximately 3 gpm of fresh water is injected into the dependanizer and depropanizer overhead lines. The result is a dilution of the cyanide and sulfide compounds in the vapor condensers to the point where apparently the galvanic relationship between steel and brass is such that steel again becomes the depleating anode.

**Conclusions**—At the present there appears to be no absolute countermeasure to hydrogen attack. There are, however, a number of things that can be economically done to reduce this deterioration.

On a local basis where more concentrated attack occurs, such as the vapor phase in dependanizer and depropanizer reflux drums, a protective liner will provide ample countermeasure. As a rule, concrete provides the most economical lining where the vessel can be removed for repairs on fairly frequent intervals.

On a general basis where cyanide is the accelerator, some combination of water washing and air injection seems to be the most effective countermeasure. Problems of proper water contact of the gas streams and disengaging facilities apparently limit the effectiveness of water washing. Probably the limiting factor in air injection is time lag in the stepwise reactions. Also, all these reactions are reversible, which may require a tremendous excess of oxygen for complete reaction of all cyanides.

**ACKNOWLEDGMENT**

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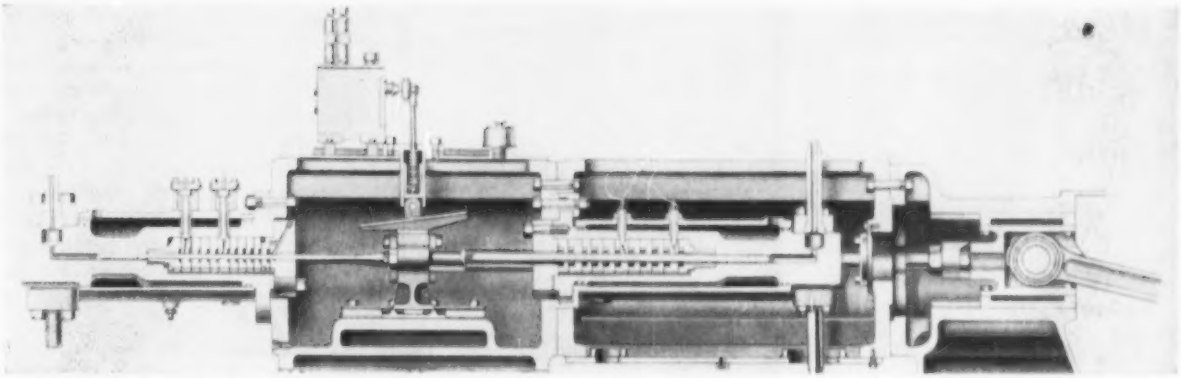

FIGURE 1—An example of how multiple lubrication feeders to packing glands operating in the 15,000 to 35,000 psig range can save downtime.

# How to Reduce Compressor Downtime

**Here's why preventive maintenance starts with design and follows through installation and operation.**

**J. J. Julian and R. A. Schaefer**
Worthington Corporation
Buffalo, New York

MAINTENANCE is not restricted to the actual physical upkeep of the compressor. It includes the practicing of sound engineering principles in machine selections. Detailed engineering studies with respect to design, as well as location and the operational pattern, will offer dividends in reduced maintenance cost and downtime. Compressor maintenance begins on the designers drawing board.

Current trends in compressor designs are spectacularly influenced by special requirements of the process industries. The handling of extremely hazardous gases and the demand for more compact, easily installed compressors frequently of the multi-service type, have brought about entirely new concepts of design. Higher pressures, too, have introduced new approaches and new ideas to combat increased maintenance costs.

Whereas compression ends have been altered considerably, the greatest changes have taken place in running gear arrangements, improved lubrication, and in balanced force designs. Higher speeds, and short strokes have also come to the fore.

**Bearings**—The old methods of bluing, scraping and tedious fitting of main and crankpin bearings have been largely supplanted by present day precision bearings. Shim adjustments have been done away with on many machines, and the larger, newer compressors now employ split shell, babbitt faced bearings. These bearings are precision bored and honed to exact size in the manufacturer's shops, so that replacement merely calls for sliding out the old shell and replacing with a new, low cost bearing. Designs are such that this maintenance can be accomplished without removing crankshaft or connecting rod.

**Piston Rods**—Piston rods of adequate cross-section to handle existing column loadings, plus a sizable safety factor, will add years to machine life. Since the rod is actually a beam supported on one end (crosshead) with a load on the other, the cross section must be designed to withstand whipping and buckling under maximum operating conditions. This is especially critical on superfinished rods on high pressure service.

Maximum tolerable deflection approximates .002-inch for low pressures and .001-inch for high pressure. Deflections exceeding these values will cause the piston to run out of true, with a tendency to dig into the cylinder bore. Packing suffers likewise, by cocking and binding in the cases, wearing unevenly, and with a reduced area for leakage prevention.

Thread grinding of the rod at the point of connection to the crosshead is important to assure alignment.

Stress concentrations are present at the root of any V thread. Poorly cut threads not only impair alignment, but resultant stresses may cause failure, with tragic results to the compressor. Precision ground threads are essential.

**Connecting Rod Bolts**—Likewise is this true of the connecting rod bolts. Selectively fitted nuts, on precision ground threads avoids binding of the nut on the bolt, and assures evenly distributed loading.

**Foundations**—Compressor operation is only as successful as its support planning permits. Featured in any compressor plant study is consideration of the foundation.

Foundations should be suitable for existing soil conditions. General practice dictates that soil loading should not be more than one quarter of the maximum soil bearing pressure. This figure takes into account the increased requirements of dynamic loading. The recommendations of a reputable foundation consultant should be closely followed.

Frequently, available foundations

## Compressor Downtime?. . .

will determine the types of compressor ultimately installed. Alluvial soils, soft clays, and sand, will sometimes require machines with balanced inertia forces, supplemented by increased foundation bearing areas. Isolating mats from the building proper should also be considered to prevent vibration transmittal.

**Airborne Dust**—The suggestion of outside cleanliness is not that the aesthetic sense must be satisfied, but a practical realization that airborne dust and dirt can sift onto wearing surfaces through crankcase breathers (better make sure it's a filter type), loosely fastened inspection openings, and frame oil head distance pieces.

The average industrial location contains particles suspended in the air that are composed of actual earth, coal, flue dust, moisture, and other matter. An average concentration is about 1-2 grains per 1000 cubic feet, becoming considerably heavier in process areas. The size of the grain is approximately .0002 inch in the average industrial location, increasing in size to be visible to the naked eye in some process concentrations.

Where intake gas filtering will protect compressor cylinder bores, only the housekeeping of the operator lends a degree of safety to the running gear. Gasketed and tightly fastened inspection doors, helped occasionally by the cleaning rag, will add to your machine life.

**Internal Dirt**—It can be estimated that 50 percent of compressor operational difficulty leading to down-time, can be traced to inadequate cleaning, flushing, and blowing out of the piping system before initial starting.

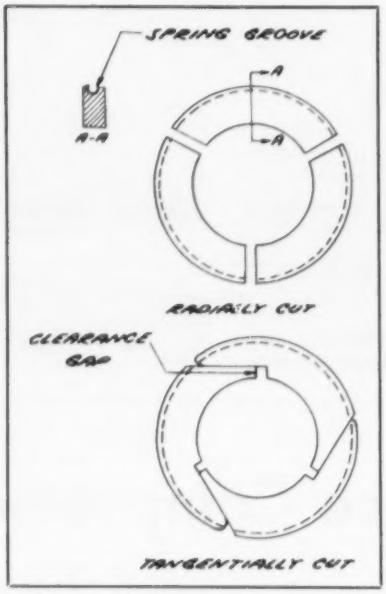


FIGURE 2—Typical segmental packing cutting pattern.

Rust, scale, weld shot and process debris manifests itself in fouled valves, scored cylinders, scuffed pistons and leaky packing.

Dirt is not from piping alone, but can also come from the gas handled. Sediment and moisture laden process gases for instance, can cause equally as large a repair bill as weld shot and scale.

Cleaning and drying of the gas before entry into the compressor is essential. Filtering devices in the form of scrubbers, traps, or tanks, should be of sufficient size to reduce gas velocities to about 500 fpm. Lower velocities will permit an even greater separation efficiency, but economic considerations indicate that 500 fpm is a practical limit.

**Gas Piping**—The arrangement of cylinder suction piping should be such that loops and pockets are eliminated, preventing an accumulation area for dirt and moisture to be eventually drawn into the cylinder.

Suction piping should be pitched toward the cylinder, with a dropleg or trap intercepting the gas flow. Discharge piping should be pitched away from the compressor cylinder, with adequate trapping to collect condensate on the downstream side of the unit.

Welded piping systems should be cleansed before installation by pickling, sand blasting, hammering and blowing. Washing pipe to remove scale and loose material is also recommended—but don't try scrubbing with inflammable solvents unless you plan on immortalizing the operator.

Gas piping to and from the gas cylinder must be firmly supported to avoid harmful stresses. Pipe hangers and floor supports should be used with due consideration to pipe con-

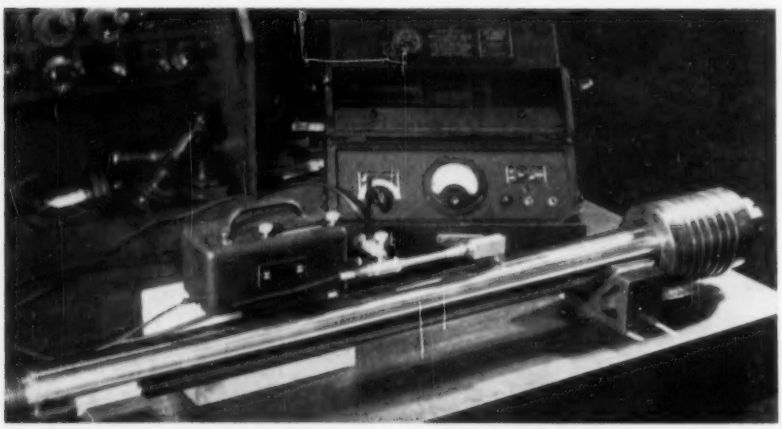

FIGURE 3—Method of inspecting superfinish to 5 micro inches on ultra high pressure piston rod.

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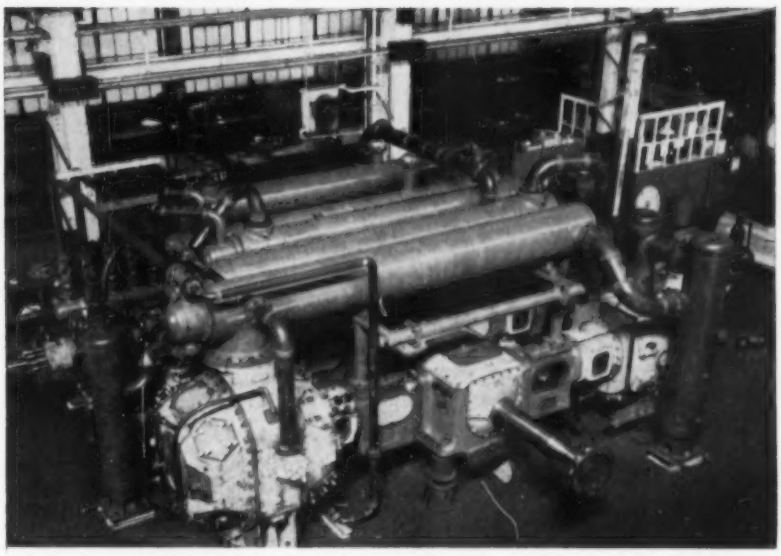

**FIGURE 4—Shop assembly of a reciprocating compressor to check fitup including intercoolers and piping.**

traction and expansion. Where long runs of discharge piping are involved, expansion joints are mandatory.

Wall supported piping should be positioned to minimize vibrations. Transmittal of pulsations from the compressor to the building is a real possibility if the piping is fixed in a wall with a great number of windows.

**Lubrication**—The lube oil system is aptly called, "the heart" of the compressor. It may well be then, that the major portion of operating maintenance will be concerned with lubrication.

Rapid deterioration of metal on metal will occur when the protective film of lubricant is missing. It is estimated that the greatest wear, due to friction, occurs during the 1 percent to 2 percent operating time when the compressor is being started or stopped.

During normal operation, the crankshaft is supported throughout the entire bearing length by an oil film, the optimum bearing area being approximately L $\times$ ¾D, where L is the length and D is the diameter.

In the short interval of time necessary during starting and stopping, either the oil system has not succeeded in supplying the protective oil film, or the film has deteriorated before the compressor has stopped. On larger compressors, therefore, some auxiliary means should be provided to flood the bearings before starting.

This can be either a hand operated, or electric motor driven gear pump. If electrically driven, the pump should be tied to the main motor starter circuit to insure that the auxiliary, start-up pump begins operation first, and runs for a short interval after the main motor circuit has been broken.

On positive pressure feed systems, the lube oil pump discharge should be adjusted for about 35 pounds per square inch delivery pressure. Adjustments should always be made at the hot oil temperatures; on high speed compressors, (300 revolutions per minute and above) the hot oil ranges from 135 to 140 F., with about 125 F. in the slower speed and splash-flood units.

These temperatures should be carefully logged each day to establish that the system is functioning correctly. Operation with recommended temperatures indicates that acceptable viscosities are available in the lube oil proper.

Temperatures will, of course, affect viscosities considerably, and for this reason oil coolers are recommended, and used on larger horsepower compressors. Frictional heat is of such a magnitude on these compressors that some means of oil temperature control must be provided.

Fouled tubes in the oil cooler will impair the heat transfer qualities, perhaps to a low enough level that oils will enter the distribution system at a lower viscosity than is proper for maximum, anti-friction performance.

Filtering is equally important for bearing life. Bearing faces form themselves into the contours of the journal offering least resistance; that is, each bearing conforms to the individual journal on which it runs. An alteration of this "skin" by excessive quantities of sediment imbedding themselves in the babbitt, will affect this skin and contouring, to the extent where it may cause seizing or babbitt wiping.

Filters should be changed, or cleaned, every time the oil is changed. Replacement cartridges should be on hand for the immediate insertion during an emergency condition.

Removing the bottom of the filter case and crankcase sump for cleaning at the time of the oil change will also insure maximum cleanliness at all times.

As a general rule, all compressors are supplied with mechanical lubricators for the compressor cylinders. Some processes are of such a nature that non-lubricated construction is employed which does not use cylinder lubrication.

On those units requiring mechanical lubricators, the lines should be disconnected at the junction of the check valve and lube oil lines leading to the cylinder bore for periodic inspection and priming. Pumping the lubricator by hand prior to every start facilitates lubrication by replacing the lubricant that has slipped from the cylinder wall during the shutdown period.

The number of lube oil feeds required in a cylinder varies with the gas handled, pressure, and size of the cylinder. For instance, a compressor handling a saturated gas will require a lubricating oil quill inserted in the suction port. Dispersion of the oil droplets into minute particles by action of the entering gas, lubricates suction valves as well as supplementing cylinder wall lubrication.

As a general rule of thumb, 4-6 drops per minute, per feed, per 1000 square feet of swept surface is adequate. This figure may vary considerably, depending on the pressures involved, amount of moisture entrained in the gas, and the condition of the cylinder bore.

**Packing**—Piston rod packing life

and lubrication are interrelated. Oil is necessary as a sealing agent and anti friction medium in the packing gland as it is in the cylinder bore. Packing must receive equal consideration from designer and operator alike.

One oil feed per set of metallic packing is normal; however, wet gases or high pressures, (Figure 1) may dictate that additional lines be fed into the gland. Metallic packing should be removed periodically, dependent upon the service, for inspection of the rings and cases.

Consisting of two, three-piece rings in each case, one ring is tangentially cut with its mating ring radially cut (Figure 2). The radially cut ring seals the tangentially cut ring, and is first in the two-ring assembly, from the end of the box.

On high-pressure service in particular, the individual ring sets are encased in precision lapped cases. In cleaning the cases and rings, care should be taken that these surfaces are not marred in any way. A slight scratch, only several thousandths deep could lead to serious packing problems. Erosion, wiredrawing and ultimate carbonization due to heat will follow, limiting the function of the packing.

On ultra high pressures, piston rods are superfinished to about 5 micro inches, making it imperative that rings also be well fitted, and without burrs, before beginning operation (Figure 3).

As the packing rings wear, the spring gradually loses tension, causing the ring segments to butt against each other. Releasing the inside diameter ring faces from the rod causes the resultant leakage.

By filling the ring ends, and changing the spring length to correspond, the packing can be serviced to provide many additional hours of good operation.

Many compressors using soft fibrous packing are still purchased. The life of fibrous packing is not equal to the metallic packing, nor is it equal in leakage prevention, but its maintenance cost is relatively low.

Usually impregnated with graphite, fibrous packing is installed in the gland with slant-cut ends, staggered to minimize blowby. Oil feeds are generally not found here due to the inherent lubricating qualities of graphite, but squirting oil on the piston rod, and into the gland before starting is still a good idea.

Soft, or fibrous packing, unlike metallic cannot be drawn too tightly into the gland. The soft strands will compress readily, increasing their grip on the rod proportional to the torque exerted on the stuffer nuts. The increased frictional drag will cause the rod to heat, possibly scoring.

Stuffers should be evenly drawn tight, then backed off one or two flats on the nuts, or just enough to insure snugness without having a sloppy stuffer.

Packing materials are varied, ranging from the aforementioned fibrous to cast iron, bronze, and stainless steel. Micarta rings on wet hydrocarbon gas service, for lubrication assistance, are also common, as are carbon packing rings on non-lubricated machines. Construction is similar, with varying degrees of operating life, depending upon the material involved.

**Jacket Water Cooling**—On those compressors requiring jacket water cooling, jackets should be large, and easily accessible through oversize inspection doors. The accessibility, for cleaning purposes, is especially critical when handling untreated raw water. The deposition of mud, minerals, and assorted debris on the jacket walls, impairs circulation abilities of the system, and decreases heat transfer efficiencies.

Clogged jackets create "hot" spots in the cylinder, causing possible seizure of the piston and scoring of the bore and rings. On compressors handling oxygen as an example, this could be tragic.

Temperatures of the inlet water should approximate 10-15 degrees above the dew point of the incoming gas. Lower temperatures will cause condensation within the cylinder bore, diluting lubricants, with a subsequent increased rate of wear.

Differential temperatures between inlet and outlet should be controlled by regulation of flow to maintain a maximum of 30 degrees. The maximum outlet temperature should not exceed 140-150 F.

Intercooler water, which is generally taken from the coldest source available, can be used for jacket water, at its upper temperature. In many cases a heat balance of the plant water system will indicate other sources of jacket water supply. Figure 4 shows the shop assembly of a machine including intercoolers and cooling water piping.

Intercooler water consumption is usually based on a 15 degree approach to the inlet water temperature. That is, the gas temperature out, will be within 15 degrees of the incoming water temperature. Closer approaches can be obtained, but economics indicate the savings in horsepower, balanced against the increased cost of the cooler, and higher water consumption, reach an optimum value at the 15-degree limit.

**Safety Devices**—The practices of preventive maintenance demands also, that the compressor and associated system be equipped with suitable safety and alarm devices. Relief valves for high pressure protection; lube oil pressure failure switches for compressor shutdown upon low lube oil pressure; overspeed trips for steam and gas engine driven compressors; bearing temperature detectors for connection to alarm systems in the event of overheated bearings, and similar mechanical and electronic watchmen.

High gas temperature detectors, blinker lights for visual check of mechanical lubricator operation, and high water temperature alarms are also found in many plants.

Thermometers and pressure gages, strategically placed, enable operators to observe the compressor's "pulse." Malfunctioning of the compressor can then be detected while still in the early stage.

Jacket water shutoff valves, for water conservation, are also desirable. Either pneumatically, or electrically operated, these valves can be connected to shut off the jacket water supply to the compressor upon shutdown of the unit.

**Inspection**—Periodic maintenance schedules are necessary to actively pursue a preventive maintenance program.

Recording temperature and pressure devices, especially in remotely placed machines, are a good investment. Continuous logs can be obtained from such instruments, and should be supplemented with other pertinent data such as oil changes, dates, quantities, compressor shutdowns, and reasons for same, together with a listing of repairs, nature and cost. ##

FIGURE 1—Partial view of refinery of The Bahrain Petroleum Company Limited, taken from the top of the fluid cat cracker.

# How Bahrain Is Maintained

**Effective training, "forward" planning, and human relations are needed in an overseas operation.**

**L. E. Machin**
California-Texas Oil Company, Ltd.
New York

IN MANY WAYS organizing and running a Maintenance department for a large overseas refinery is essentially the same as for a domestic refinery. But an arid island such as Bahrain brings many peculiar problems.

The Bahrain Petroleum Company Limited (BAPCO) a member of the Caltex Group of companies, operates a completely self-sufficient 200,000-barrel-per-day refinery covering 350 acres on Bahrain in the Persian Gulf. Bahrain is an island 30 miles long by 10 miles wide, the largest in an archipelago of the same name 20 miles off the east coast of Saudi Arabia. It is an independent Sheikdom far from all sources of supply.

BAPCO's Refinery's Maintenance department is organized into five areas each under the direct supervision and responsibility of an area supervisor. Tradesmen are scheduled into these areas on a day-to-day schedule but based on weekly requirements of work to reduce unnecessary movements of manpower. Craft foremen are responsible for the shops, for the quality of the work put out by the tradesmen and for the training and development of the men. The area supervisors are responsible for the over-all job quality and quantity in the areas.

With area organization for maintenance, the small day-to-day routine and/or repetitive preventive maintenance jobs are done by assigned maintenance personnel in that area. The remainder of the work in the area is analyzed and plans are made on a weekly basis so that transfers of men from one area to another are kept to a minimum. This is considered more efficient for maintenance continuity and for better quality of maintenance in any one area.

Although the basic structure of the maintenance organization is essentially the same as that of a domestic refinery, the accent on some aspects of the dynamics of organization is high. Personnel administration, training and human relations problems require major attention by the maintenance supervisors no matter what their levels.

**Organization**—One major difference from the usual domestic refinery is that the maintenance organization is extended to include maintenance of activities outside of the refinery, such as a self-contained village of 2500 people, wharves, harbor, and launch activities, a producing field and transport operation involving 600 pieces of equipment and 1000 men.

The organization has to be staffed to take care of the abnormal lost time due to vacations of European, North American and Indian employes. These employes earn foreign service vacation credits and, depending on their status, are away from Bahrain from 3 to 4 months every 2 to 3 years. And, under certain conditions Bahrainis may also accumulate vacations equally long. This creates gaps which must be filled and is a natural problem of scheduling that the company recognizes, and for which adequate provisions are made.

Additional care and emphasis must be taken in assuring adequate supervision for maintenance men who come from almost all parts of the world. In 1954 the number of employes by nationalities were:

| | Maintenance Department | Total BAPCO |
|---|---|---|
| Australian | 5 | 44 |
| Bahraini | 2,675 | 5,829 |
| British | 292 | 1,002 |
| Canadians | 2 | 14 |
| Indians & Goanese | 206 | 612 |
| Iraqi | 2 | 5 |
| Irish | — | 18 |
| Pakistani | 81 | 132 |
| South African | 1 | 7 |
| U. S. A. | 6 | 42 |
| Others | 122 | 827 |
| TOTAL | 3,392 | 8,532 |

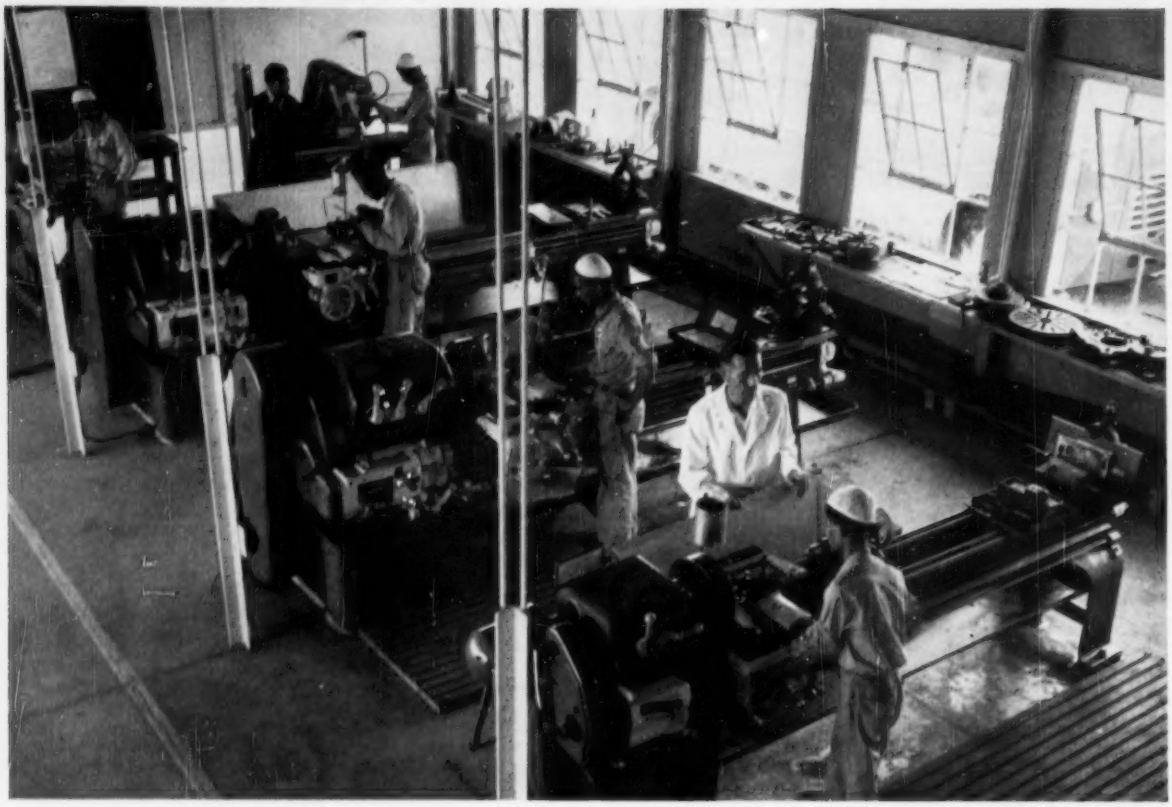

FIGURE 2—The machine section of BAPCO's Craft Training Center contains modern equipment on which students receive detailed instructions.

Many different backgrounds, experiences, traditions, and languages all make the maintenance supervisor's job a difficult one to weld this group into an efficient, harmonious, integrated department. Such an operation, that is so wide in scope and so complex, requires men with many varied skills and occupations.

The Maintenance department must be ready and capable at all times to perform such jobs as repairing automatic telephone stacks, balancing the sound of the movie projector circuits in a six hundred seat theater, diving to install an underwater patch on a tanker, as well as making intricate parts for pumps and equipment and keeping the refinery operating and on stream.

**Human Relations**—In a foreign operation where the company must make available living quarters, food, and almost all the amenities such as movies, sport recreation, transportation, many personnel problems arise from various causes. These problems, both real and imaginary, outcrop on the job and as a result the supervisors must handle more personnel work than they would in the equivalent domestic operation. Because of this, most of the European and North American employes must function as supervisors and personnel administrators regardless of their level in the company.

In any industrial operation, selection of recruits is important. However, for a foreign operation as complex as that of Bahrain's, selection of recruits is absolutely vital. In addition to trade abilities, men must have supervisory potential. They must also have the ability to adjust to foreign service environment, complicated by severe summer temperatures.

It also becomes necessary to interview and evaluate the compatibility of a candidate's family for foreign service. If this is not done, it may be discovered too late that an employe's wife or his children cannot adjust to living conditions in a small village and the entire family must be repatriated at considerable expense to the company and lost effort in developing and training the employe. Recruiting of incompatible employes will result in high turnover rates.

Due to the very nature of foreign service, BAPCO normally recruits an employe on bachelor status in order that both he and the company may appraise each other to determine whether he should continue on a career basis. The policy is to bring a man to Bahrain for a period of some months before he is assigned a house for his family. This policy, coupled with the fact that the new employe is in a completely different environment, puts him under an additional strain not experienced in domestic service. This can result in new employes' confronting their supervisors with personal problems not ordinarily encountered domestically.

**Training and Development**—Training and development of all types of employes is desirable in any organization; in Bahrain it is particularly critical. It is BAPCO policy to train, develop and advance the Bahraini employe as rapidly as he can

**FIGURE 3—Head instructor of the BAPCO Craft Training Center with staff of Bahraini experts.**

assume increased authority and responsibility. To achieve this, the company operates its own elementary school and trade school which supplements the Bahrain government educational program. As of December 31, 1954, 1324 Bahrainis had attended BAPCO's elementary school. Training-within-industry courses are held for all employes in job instruction training and job relations training. One of the most successful schools has been the welding school where Bahrainis learn both arc and gas welding. The school's success is indicated in that the welding group of the Maintenance department employs only 17 Europeans, but 118 Bahrainis and Indians.

An active supervisory development program was begun three years ago in order, first to appraise existing personnel and second to set up planned training and development of these men so that the company can adequately fill its supervisory requirements.

Turnover rates appear slightly higher than the domestic petroleum industry. This has run in the order of 1.75 percent per month compared with the figures of the Bureau of Labor Statistics which indicate rates from 0.75 to 1.25 percent. The high rate has been partly due to the fact that the Caltex Group of companies has been expanding rapidly and looks to its largest operation, Bahrain, as a source of supply for top supervisory and technical talent.

Thus it can be seen that rapid training and development of supervisors is a critical and pressing job for this organization.

**Spare Parts**—The adequate stocking of spare parts is a particularly difficult problem when the sphere of operation is several thousand miles away from any source of supply. In order that the operation be covered for spare parts, a procedure has been developed which is flexible, depending upon current deliveries.

The Maintenance department is responsible for recommending to the storehouse what parts should be stocked for any one piece of equipment. Maintenance also estimates annual consumption. The storehouse policy is to order six months supply when stock has been reduced to 12-month minimum supply.

In order that the Maintenance department does not run out of spares, continuous working contact with the storehouse must be kept. On the other hand, Maintenance must beware of overstocking, and must advise the storehouse when any major piece of equipment is due to be retired because of corrosion or obsolescence so that its spare parts can be reduced in stock.

Maintenance also works closely with the engineers to obtain as much standardization of equipment as possible. This simplifies both maintenance and the ordering of spare parts because employes then become familiar with the equipment.

Thus, even in details, forward planning is the basic work that goes into foreign refinery operation—planning ahead for supplies, for markets, and above all for employes and their families with regard to general welfare, education, and their happiness in the organization. This is the only way that an installation like the Bahrain refinery can make its contribution to the petroleum needs of the Free World. ##

## Meet the Author

L. E. MACHIN is assigned to the New York offices of California Texas Oil Company, Ltd., to handle maintenance and operating engineering problems for companies of the Caltex Group. Machin joined Caltex in 1938, following his graduation from the University of British Columbia, with a degree in chemical engineering. He started with The Bahrain Petroleum Company as an operator of thermal crackers and served that company 17 years, rising to chief engineer and finally manager of maintenance, transportation and general services before he was transferred to the group's New York office.

MAINTENANCE

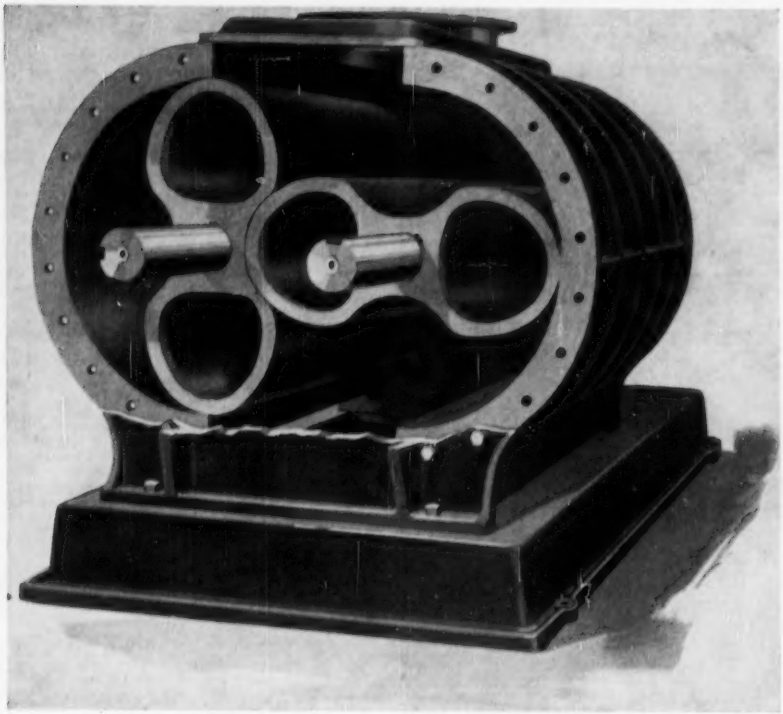

FIGURE 1—Impeller arrangement in a straight lobe type blower.

# You Can Cut Blower Maintenance Cost

**Getting the most in dependability and low maintenance cost from your blower starts with selection and installation.**

**J. L. Hylton**
Roots-Connersville Blower
Connersville, Ind.

FEW THINGS cost so much so fast as process unit downtime. A rotary blower is usually a key equipment unit, critical to the process. To get the most dependable use, your preventive maintenance should start with the machine selection. Then you must follow thru with careful installation, operation, and routine maintenance. These are the things that will pay dividends.

Trouble-free blower operation begins with the proper selection and application of the unit. If the blower does not have correct performance characteristics, if the mechanical design is not suited to the application, or if it is poorly installed; unsatisfactory operation will result.

**Selection of Rotary Blowers**—Rotary blowers or compressors can best be defined as positive displacement type machines in which compression is achieved by the positive action of rotating elements. These rotating elements may be in the form of longitudinal vanes which move radially in a rotor within a cylinder, or may be two mating lobed impellers revolving within a cylinder; impeller contact being prevented by timing gears mounted on the rotor shafts outside the cylinder.

These impellers are manufactured in several shapes ranging from straight lobes (Figure 1) to a spiral or screw type arrangement (Figure 2). The following information pertains primarily to the two impeller rotary positive displacement type blower; although many of the procedures mentioned are also applicable to other types of rotary blowers and compressors.

The nature of the process or application, available space, sources of power and geographical location are all determining factors in the selection of a specific type of compressor.

It is the responsibility of blower manufacturers to acquaint a prospective user with the characteristics, advantages and the benefits which are to be derived from the use of a particular type of blower. With this information, the user must then select the type which he feels is best suited for the application or process at hand.

Once the type of compressor has been decided, the prospective purchaser is ready to select a specific make or model. A very important factor often overlooked in this final phase of blower selection is the amount and ease of maintenance to insure desired operation with minimum of downtime.

**Make Manufacturer's Instructions Available**—Regardless of the type of blower or compressor finally selected, preventive maintenance should commence with its installation. Most manufacturers supply installation, operation and maintenance instructions with their equipment; although some are more complete than others.

Very important and many times overlooked, is insuring that the manufacturer's instructions are given to or made available to the personnel who are to install and/or operate the blower. The most complete instructions ever written will be worthless if they are not available to the men who uncrate the equipment, place it on the foundation, start and operate it.

Make certain that all personnel reads and follows the manufacturer's instructions for the installation, operation and maintenance of their blowers and compressors, since the detailed procedures may vary with the make of blower. If ever in doubt concerning a proposed action, consult the

blower builder. The chances are that he will go along in all but rare instances. Moreover, you'll have the satisfaction of knowing that the blower builder is 100 percent behind you and approves the contemplated action.

**Blower Installation—Foundation**—Incoming blower shipments should be carefully checked for damage in transit and packing lists scrutinized to insure receipt of all parts. Any damages in transit should be reported immediately to the shipper and the transportation company. All material shortages should also be reported to the manufacturer at once. This gives him an opportunity to replace the missing items with a minimum of delay. Accessories, small parts and special fittings may have been boxed separately and should not be overlooked.

Unload and uncrate the blower carefully, cautioning personnel not to put any strain on the shafts. As far as possible, move by means of chains or ropes preferably fastened under blower headplates and baseplate as illustrated in Figure 3 and Figure 4. Lifting holes or eyes may be provided in the baseplates of larger blowers and compressors for securing chains or cables. Position the points of support so as to not subject bedplates to unusual or excessive strains.

If chains or cables are used, they should be blocked out from the bedplates to prevent unusual strains on the cylinders, piping or mounted accessories. Move the blower as near the foundation as possible before removing the skids.

Most blowers require a concrete foundation, the depth of which depends upon the subsoil and the weight and size of the unit. In general, the depth of the foundation should be at least twice the distance between the blower shaft centers. The length and width of the foundation should be such that the anchor bolts will be six inches or more from the edge of the concrete.

It is imperative that blowers be set so that they are not in a twist. Twisting can be avoided by setting the unit level. A machinist's level with a ground glass vial should be used on the clean finished surfaces of the baseplate. Check the level both lengthwise and crosswise prior to grouting or tightening anchor bolts. When an outer bearing is used, care must be taken to bring it up to correct alignment with driving shaft. Leveling screws are furnished with larger blowers to accomplish final leveling. Twisting or distortion of a blower on the foundation will result in impeller contact during operation due to the very close internal blower clearances.

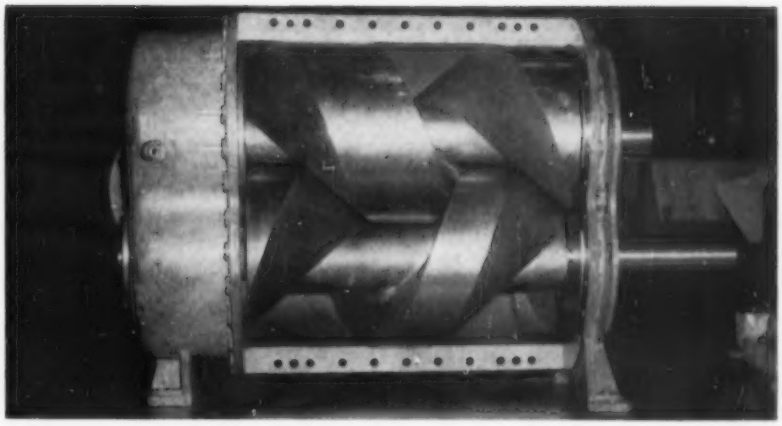

FIGURE 2—Impeller arrangement in a spiral type blower.

Blower drivers, if mounted separately, must also be leveled and very carefully aligned with the driven unit. If connected through flexible couplings, the coupling must be lined up for parallelism and angular misalignment.

**Blower Installation—Piping**—The inlet and discharge piping to the blower should normally be the same size as the blower connections. Smaller piping acts to restrict the flow of air resulting in high pipe losses, increased power consumption and possible compressor overload. All flanges for making pipe connections should be brought square and flush with the blower flanges. Correction of pipe misalignment should never be attempted by forcing the piping into position with the flange bolts.

Most blowers are designed to carry a reasonable pipe weight, but will not withstand cramping of pipe connections. Pipe supports located near the blower are normally recommended on larger sizes to avoid excessive strains or weight resulting in distortion and internal blower contact.

Piping and accessories should be clean and free of scale, refuse, waste or other foreign objects before connecting it to the blower. A check should also be made to insure that nothing is located near the blower inlet which could be sucked into the air stream and into the blower when it is started.

**Blower Start-up**—After the blower has been secured to the foundation, aligned, and the piping connected; the manufacturer's instructions concerning lubrication should be carefully checked. Most blower manufacturer's lubricating instructions are explicit and should be closely adhered to. The following checklist is applicable to rotary blowers and should be gone through prior to unit start-up:

1. Turn the unit over several times manually to insure that the impellers revolve freely.
2. See that any line shut off valves are open and that no restrictions exist which might cause excessive pressure at start up.
3. Check inlet of air stream for loose objects that might be sucked into the blower.
4. Check oil levels to ascertain they are within the recommended range.
5. Check anchor and mounting bolts to see that all are properly secured.
6. If blower includes oil cooler or other cooling system, check flow of cooling water.
7. Check driver for proper lubrication.
8. Check coupling for proper lubrication.
9. See that blower driver has been properly wired or piped.
10. Ascertain the correct direction of rotation of both the blower and the driver.

Upon completion of this checklist

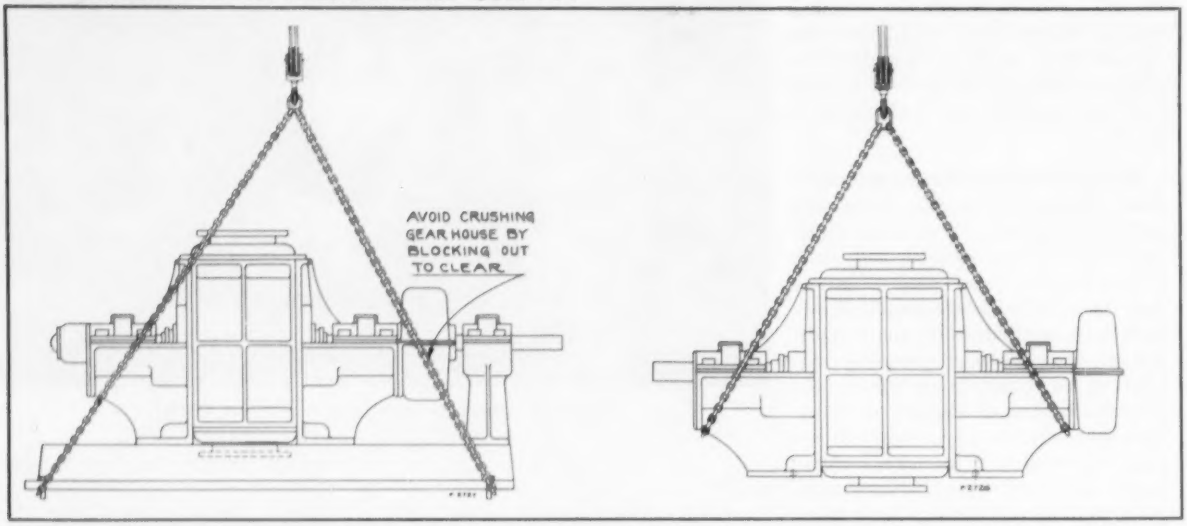


FIGURE 3—Lifting arrangement for machine on base plate, to avoid damage.

FIGURE 4—Lifting arrangement for bare machine, to avoid damage.

the blower is ready to start. If possible, it is recommended that the blower be initially started unloaded. If the system includes a relief or bypass valve, the flow may be bypassed and the load applied gradually after the unit is up to rated speed.

**Post Start-up Check**—During and immediately after starting the blower, the following points should be checked and noted:

1. If the blower is pressure lubricated, note the oil pressure gage. If recommended oil pressure is not evident within one minute of operation, shut blower down and check the lubrication system.
2. Observe window in top of gear cover on two impeller blowers. Oil splash can be observed if oil is being supplied to the gears.
3. Observe the oil level in the sump to see that it has not dropped below recommended minimum. Oil should be added if necessary.
4. Feel the vibration of the unit to see if it is excessive on either end of the blower or on the driver. Blower vibration of four to five mils is not unusual.
5. Note blower cylinder while the load is being applied and for a few minutes thereafter. Should impeller contact or impeller-cylinder contact develop, a hot spot will appear on the cylinder evidenced by smoking and a scorched paint spot.
6. Inspect oil piping system and blower baseplate for oil leaks. Tighten unions and couplings if necessary.
7. Observe pressure readings to see that they are not excessive.
8. Inspect auxiliary and safety devices to insure their operating satisfactorily.

**Inspection and Maintenance Procedure**—With a blower installed and operating satisfactorily, the intelligent and cost-conscious company will institute a periodic inspection and preventive maintenance program. Regular inspections should be made at definite intervals, at which time any necessary corrections can be made; such as replacement of worn parts, cleaning impellers and maintaining recommended oil levels. Such a program is designed to detect and minimize normal equipment wear and insure satisfactory operation.

The key to regular and systematic maintenance is a comprehensive reminder and record system. Many blower users have a single check chart which admirably combines both functions. This chart should be located near the blower, where it is both visible and usable.

List on it all maintenance procedures—and the dates for doing them. Provide space on the chart for entering the date and personnel initials for all maintenance functions. The chart or checklist can be developed from the blower manufacturer's instructions or specifications.

**Lubrication**—There is no internal contact between impellers or between impellers and the case on rotary two impeller blowers, so no internal lubrication is required. After a blower is first put in service however, the external lubrication and oil level should be checked every day for the first week and thereafter at least once every week.

The oil should be changed as required by its condition which will be determined by the location of the installation and the application of the blower. In general, the oil should not require changing more frequently than every 2000 hours of operation; unless the blower is installed outside, or in a very dusty atmosphere.

If the unit is pressure lubricated, the oil pump and filter should be inspected with each oil level check. The oil filter and strainer should have any sediment removed. Oils of the following viscosities are recommended for the lubrication of bearings and gears on all types of two impeller rotary blowers operating under normal temperature conditions.

| Size | U.S.S. Saybolt 100 F. | S.A.E. |
|---|---|---|
| Up to 25 bhp..... | 400- 700 | 30 |
| 25 bhp & Up..... | 700-1000 | 40 |

The blower manufacturer should be contacted for recommended oils on those installations where unusual temperature conditions prevail.

High temperature ball bearing grease should be used on units requiring grease for the bearing lubrication.

**Gears**—The gears that maintain

the blower impellers in proper rotative position are cut with sufficient backlash to give proper operation and are keyed onto the shafts. One gear may be adjusted by shifting of the gear key. Consult the manufacturer however, before attempting to change the timing of gears.

Gear condition can usually be determined by noise. Any unusual gear noise should be investigated immediately so that the cause of this condition can be corrected. Gear failure may be by wear or by tooth fracture. Tooth fracture results from overloading which may be only a momentary shock load.

The fracture is most likely to occur at the root of the tooth. Tooth wear erodes the contact surface and results from steady overloads and/or improper lubrication. Extensive gear failure may cause loss of proper gear timing which permits the impellers to contact each other. Serious damage to the blower may result.

The top half of the gear cover should be removed every six months to ascertain the general condition of the gears. On this inspection the inspector should look for gear "cross-fire" contact. This condition will cause very rapid wearing of the gears and may be due to one or more worn bearings, baseplate being out of level or cylinder twisted by pipe strain. Should this condition be found, contact the blower manufacturer for special instructions or request the service of blower erection engineer.

**Bearings**—Rotary two impeller blowers are furnished with sleeve type, or anti-friction roller or ball bearings. Bearing wear may gradually allow the impeller shaft position to change until a cylinder rub develops. Most blower manufacturers stock replacement bearings, but where compressor service is critical, it is recommended that the user stock a spare set of bearings for each blower.

Renewable sleeve bearings are split along the horizontal center line and can be removed by taking off the bearing cap and top half bearing and rolling out the bottom half bearing. Replacement sleeves are accurately machined and bored and are interchangeable. Anti-friction bearings are mounted in the blower headplate in bearing carriers which can be backed out to remove bearings.

Bearings should be inspected at regular intervals, as their failure can be very serious if it is sudden and the bearings do not continue to support the impellers.

**Variation in Volume**—Many companies purchasing rotary positive blowers want, eventually, to change the volume of air delivered by the blower. The discharge is positive and volume can not be controlled by restricting the pipe opening at blower inlet or discharge. Such restriction will only add to the pressure load and increase horsepower consumption. To vary the volume, either the speed must be changed or in the case of excess capacity, this excess must be discharged to atmosphere through a relief valve when the blower is handling air.

Returning large volumes of bypass air or gas direct to the inlet of the blower or compressor will build up heat and is definitely a cause of trouble unless a cooler is installed in the bypass line.

**Extended Blower Shutdowns**—When the blower or compressor is to be kept out of service for extended periods, the impellers and the inside of the cylinder should be coated with a heavy oil or grease to prevent rusting, corrosion and sticking of parts.

Before placing the unit in operation again, clean the impellers and cylinders, replenish lubricating oil in the bearings and gears, and rotate the unit manually to see that it turns freely.

**Mechanical Trouble**—If mechanical troubles are experienced in starting or during operation of a blower, the manufacturer's instructions pertaining to leveling, alignment, anchoring strains, piping alignment and support and obstructions in the blower or piping should be rechecked. If the trouble can not be diagnosed and corrected, do not operate the unit, but get in touch with the manufacturer or their nearest office.

In reporting trouble give complete details including size of blower or compressor, serial number, type of service, load conditions, drive details and the approximate time the unit has been in service.

Select the right blower for your application, install it correctly, operate and maintain it properly and it will cause you few troubles. So use these procedures today. They may save you trouble and expense tomorrow. ##

MAINTENANCE

## Meet the Author

JOE L. HYLTON is assistant to the sales manager of Roots-Connersville Blower, Division of Dresser Industries, Inc. In addition to his sales experience with the company, Hylton's background includes eight years as blower application manager, plus service as contract manager for the division. Before joining Dresser Industries, he was with American Kitchens as a cost accountant. Hylton is a graduate of Indiana's Earlham College and holds a master's degree from Indiana University.

**TABLE 1—Check List for Shooting Trouble in Rotary Blowers**

| Trouble | Item | Cause | Remedy |
|---|---|---|---|
| No Flow | 1 | Speed too low | Check speed and compare with desired speed |
| | 2 | Wrong direction of rotation | Compare rotation of driver with direction arrow on blower |
| | 3 | Obstruction in piping | Check piping, valves, filters, etc., to assure an open flow path |
| Low Capacity | 4 | Speed too low | See Item 1 |
| | 5 | Pressure rise too high | Check pressure rise and compare with rated value |
| | 6 | Inlet pressure too low | Check inlet pressure and compare with the rated value |
| | 7 | Obstruction in piping | See Item 3 |
| | 8 | Excessive clearances | Check inside of casing for worn, corroded, or eroded parts causing excessive clearances |
| Excessive Power | 9 | Speed too high | Check speed and compare with rating |
| | 10 | Pressure rise too high | See Item 5 |
| | 11 | Casing or impeller rubs | Check outside of casing for excessive temperatures and check internal clearances |
| Overheating of Bearings, Gears or Glands | 12 | Inadequate lubrication | Check lubrication supply and type |
| | 13 | Excessive pressure rise | See Item 5 |
| | 14 | Misalignment | Realign unit for parallel mounting and alignment with driver |
| | 15 | Excessive belt tension | Check belts for initial tightness |
| | 16 | Tight shaft packing | Repack glands and tighten just beyond finger tight |
| Vibration | 17 | Misalignment | See Item 14 |
| | 18 | Casing or impeller rubs | See Item 11 |
| | 19 | Worn bearings or gears | Check clearances and condition of bearings and gears and replace if required |
| | 20 | Build-up of material inside impellers | If tar or comparable material is handled check cored openings inside impellers |

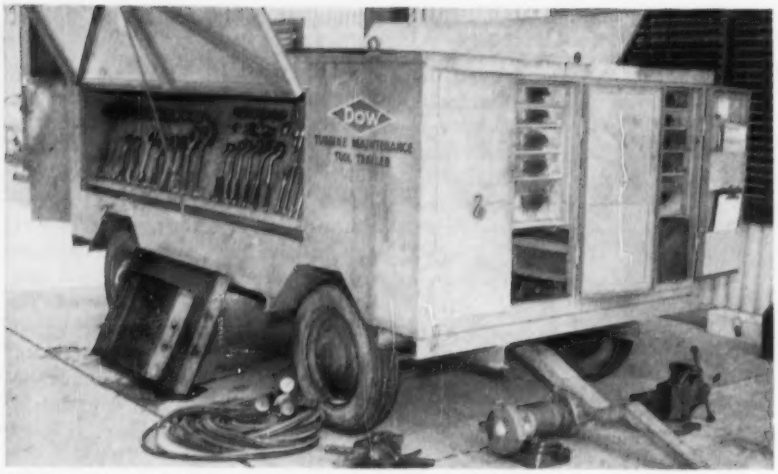


FIGURE 1—Special trailer used for turbine overhaul tools which will not fit in craftsman's box or are used only on the turbine work.

# Planning Pays in Turbine Maintenance

**Dow Chemical's thorough planning and good organization gets 97.3 percent turbine availability.**

**H. A. McGill and J. H. Zylks**
The Dow Chemical Company
Freeport, Texas

THE TEXAS DIVISION of The Dow Chemical Company has been able to maintain its turbine availability rate at 97.3 percent by scheduling overhauls periodically and performing overhauls in such a manner that forced outages are kept at a minimum. Each of 15 large turbo-generator units come down once within a two year period for inspection and overhaul, and each of its small mechanical drive turbines come down on an average of once each year for inspection and overhaul.

Scheduling of overhauls is carried out within a master plan which has been prepared and projected some three or four years in the future. This is not a rigid plan, nor can it be. It must be flexible enough to allow for those forced outages that will occur and power production must meet the demands of the production plants.

But it is a plan that the Maintenance department can use in anticipating manpower and equipment needs. With cooperation from other production plants, maintenance manpower and equipment can be spread so that there is maximum use of each. With prior planning, manpower and equipment can be distributed and used in such a way that only a minimum of lost motion and confusion will occur on short schedule overhauls during periods of urgent power demand. In fact, it is at such times that previous plans, if minutely detailed, properly executed and carried to completion, prove their worth.

Within two plant areas at Freeport, Texas, there are 15 turbo-generator units with a total manufacturer's nameplate rating of 485,000 kilowatts. These 15 machines vary in size from a small 5000 KW unit up to the largest of the group which is a 60,000 KW unit.

**Planning the Overhaul**—Since most of the machines are extraction or bleeder machines, they serve as sources of process steam as well as electrical power. Consequently, each machine is well integrated into the plant system and its availability becomes a matter for concern to many people. Before a machine can be brought down for overhaul much planning must be done by the several departments affected. These would be the Maintenance departments, the Power department, and those plants of the Production department receiving steam from that particular machine. Here are the duties of the Maintenance department during the outage and the methods by which they are performed.

The power situation is reviewed when the master overhaul schedule shows that the time for a certain machine overhaul is near. If the machine can be spared, a work order and work list will be sent by the Power department to the Maintenance department. The work order will be a written request for the work to be done. The work list will be a list of inspection work to be performed and component parts of the machine which do not function properly.

A work (man hours) and cost estimate are then drawn up by the Maintenance department and sent to the Power department. From the work estimate and the manpower available, the Maintenance department has been able to give the Power department a reasonable estimate of the length of time the machine will be down. This assumes all spare parts needed will be on hand and no great amount of unexpected repair work develops during the inspection.

By drawing upon the experience of the operating and maintenance personnel and the manufacturer's recommendation, the Power department has always kept an ample supply of spare parts readily available for those items which receive ordinary wear.

When the date for the outage has

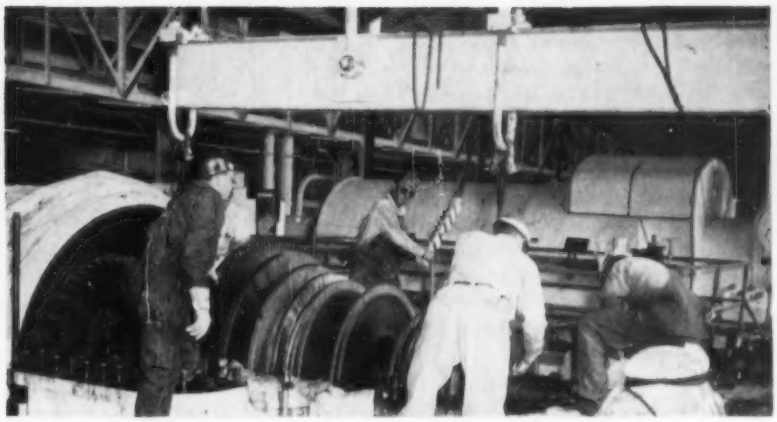

FIGURE 2—Floor operated bridge crane controls being used by second man from left.

FIGURE 3—Balancing small turbine spindle in shop balancing machine.

been approved, the work order for the overhaul is given to an area engineer. He has the responsibility of seeing that each craft involved is informed of its part of the work to be done. He makes arrangements for equipment and materials that will be needed on the job.

Each of the maintenance crafts will usually have some work to do on an overhaul. The machinists will inspect and repair the turbine and mechanical auxiliaries. The pipefitters will inspect, repair and set all major valves, and remove and renew piping. The boilermakers will inspect and repair the condenser and other heat exchangers.

The electricians will clean and inspect the generator and exciter as well as other electrical equipment. The insulators will take care of the insulation of the turbine, and steam piping. The carpenters do the scaffold work necessary. The riggers will do the rigging and make all heavy lifts. The instrument men will repair or replace those instruments found faulty. The painters will repaint the turbine, generator and auxiliaries after the overhaul has been completed.

**Organization of Supervision and Crew**—The major portion of the work done on a turbine overhaul is in that classification done by the machine shops at Dow. One machine shop superintendent has been assigned the responsibility of all work on all overhauls, in addition to his responsibility of supervising the machine shop at his particular plant area. This shop superintendent has assigned to him two technical men, one a supervisor and the other an engineer, who supply technical supervision during the overhaul.

The supervisor is usually concerned with the dismantling, repair and reassembly of the turbine proper and that mechanical work done to the generator. The engineer supervises the control and balance work. The machine shop superintendent is charged with coordinating work done by all crafts in connection with a turbine shutdown.

**The Overhaul**—Scheduled inspections and overhauls usually begin on the first of a week. Some time during the week before the floor around the machine to be opened is covered with large tarpaulins for some 15 or 20 feet around it. These are covered with regular 4 by 8-foot sheets of plywood. By covering the concrete floor with the tarpaulins and then with the plywood much of the grease, oil, carbon dust and the like will be kept off the floor. The plywood will serve as a cushion and keep heavy pieces from falling and chipping the concrete floor. The plywood is also good when placing pieces with machined surfaces on the floor.

No time is lost looking for something soft to go between the metal and concrete. To lay plywood over the floor would seem costly. Considering that in a one year period, an average of seven or more machines are down and the same plywood is used for all machines, then its reuse justifies the cost.

Racks have been made of scrap pipe and sheet iron. Transportation is a matter of picking up the racks with the crane and putting them on a truck to be carried to the next job site.

After the floor has been covered around a machine, a tool trailer (Figure 1) is moved to a point near the machine where it will be easy to get to and yet out of the way. This trailer has been fitted with two tool boards (one can be seen in the photograph, the other is in the same position on the other side), a group of drawers in the front, and a compartment in the rear where pinch bars, and other small tools, may be placed. A rectangular opening has been left in the top of the trailer into which a steel table can be lowered. The top of the table serves as a cover for the opening. Eye-bolts, which screw into the ends of four pieces of pipe that protrude through the top of the trailer and extend down to the axles where they are welded, form lifting rods. The trailer can be lifted from the ground floor to the turbine floor.

The trailer has been fitted with tools generally used around a turbine overhaul which are too large to be carried in a machinist's hand box. These tools consist of a vise and grinder that can be fitted to the metal work table, a small hydraulic jack with attachments for pulling and pressing, a ¼-inch drill, a small impact wrench that has sockets for most types of small cap screws, a set of outside micrometers from 0 to 14 inches, a set of inside micrometers, a set of snap gages, taper gages, long feeler gages, long travel indicators, vibration indicator, machinist's levels, various taps and die nuts. Also included are expendable items such as emery cloth, marking crayon, and various brushes. These items are found in the drawers at the front of the trailer. On

## Planning Pays in Turbine Maintenance . . .

one of the tool boards are various small striking wrenches, and some 1-inch drive and larger sockets with their wrenches.

The trailer does not carry all the tools needed on a job. It was not built with that in mind because some tools are used only on certain machines. These are found on the tool boards near those machines at the power house.

If the work to be done on the machine is a scheduled inspection and overhaul, it is usually begun on the first of a week with the machine that has been down over the previous week end. The machine has had a chance to cool a good bit. This makes it easier for the craftsmen to remove the lagging, insulation and that piping which will have to be broken out before the cylinder cover can be lifted. The important thing about this cooling is that it allows the cylinder flange to cool and contract.

Less heat is then required to stretch the joint bolts so that the nuts may be broken. The bolt temperatures do not reach that point at which the heat treatment might be harmed or destroyed.

A complete inspection and overhaul usually means a thorough inspection of all blading (both spindle and cylinder) and cylinder internals. Removal and inspection of all turbine auxiliaries. Inspection and adjustment of the turbine control mechanism. A balance check and balancing if necessary.

After a spindle has been lifted, it is placed in cribbing. Then it and the diaphragms or blade rings are sent to the sandblast yard. They are cleaned by blasting with a silica polishing abrasive of some 100 to 120 mesh. This abrasive has been found to do a good cleaning job without etching, even against a very hard scale.

Both spindle and cylinder blading are checked by the magnetic particle method for defects after having been cleaned. All breaks, pits, cracks or other defects are examined and corrected if it is deemed necessary. While the diaphragms are out of the cylinder, the shaft packing is removed, cleaned, checked for broken springs and the wear of the labyrinths. All main bearings are checked for cracked babbitt and wiping. Later after the spindle has been placed in the cylinder, bearing clearances are taken as well as blading and packing clearances.

The main control and stop or throttle valves are also inspected. The valves, stems and bushings are cleaned and checked for steam cutting. All valve stem and bushing clearances are checked. The hydraulic operating cylinders and the shaft bearings and bushings of those cam operated valve systems are also checked.

A check is usually made of the amount of operation the steam driven auxiliary oil pump and electric driven oil pump have had since they were last inspected. If they have not been inspected recently or have been giving trouble, they are pulled and inspected. While this is being done, an inspection of the pump regulators is made. Other auxiliaries such as steam seal regulators and vapor extractors also receive periodic inspection and overhaul.

An inspection of the control mechanism usually means a cleaning of all ports and oil passages of the speed and pressure governors of the hydraulic control system. For the mechanical system, this usually consists of checking the clearances of the speed governor drive and those moving parts of the speed governor which are subject to wear.

The mechanical system after assembly, can be checked for travel and operation with oil pressure from the steam driven oil pump. Final setting of the hydraulic control system must be done after the machine has been brought up to speed. The final check is that load which the machine will carry when a load test is made.

A practice of filtering the lubricating and hydraulic system oil has been instituted before a machine is brought up after an overhaul. This is done with the assistance of the Lubrication department and their portable oil filtering system. This system includes a full flow oil filter with filtering efficiency to 5 microns connected to a 160-gallon per minute centrifugal pump. All are mounted on a 1000-pound capacity, rubber-tired hand truck together with approximately 80 feet of flexible 2-inch hose to facilitate quick hookup. After the oil reservoir has been thoroughly hand cleaned with lint free rags, it is filled with clean oil and the filter is connected to the lowest point on the reservoir.

### Meet the

H. A. McGILL is superintendent of The Dow Chemical Company's machine shop at Freeport, Texas. In addition to his responsibilities for the machine shop, he is in charge of turbine maintenance. With Dow 13 years, McGill previously was an engineer for a large power and light concern in the Southwest, and before that he served ten years as a marine engineer.

Before the oil is circulated through the turbine system, it is filtered long enough to remove any foreign material not removed by previous hand cleaning. Filtering is continued while the oil is being circulated by the turning gear pump or by the steam driven auxiliary oil pump. Samples are checked by the lubrication laboratory at one hour intervals until samples indicate system is free of abrasives and other foreign matter that could foul oil passages and damage bearings. Filtering is usually continued from 8 to 24 hours after the machine is placed in operation to remove any foreign material that may be washed down after the main oil pump is placed in operation.

Outage of the associated heat exchanger equipment while the turbine is being repaired affords an opportunity to remove water scale accumulations in oil, hydrogen and other water cooled exchangers. Removal of this scale is accomplished through the use of hydrochloric acid, suitable additives and neutralizers. Since work of this nature requires considerable care and technical knowledge plus specialized equipment, an affiliated service group performs these services. This work is coordinated with all other work being performed.

When a machine is brought up for the first time after an overhaul, a

## Authors

JACK M. ZYLKS, a design engineer with The Dow Chemical Company at Freeport, Texas, is responsible for checking and setting turbine-control mechanisms and balancing turbines. With the company five years, Zylks previously was associated with petroleum concerns in the Southwest. He is a mechanical-engineering graduate from Texas A&M College and holds a master's degree from Louisiana State University.

careful check is made of the vibration. If during that time, no abnormally high vibration shows at any point, the machine is put on the line and loaded. Later after the machine has had time to heat and expand at load conditions, another vibration check is made. If at any time during the start and loading vibration becomes excessive, the cause is determined and corrected, whether this be a rub or unbalance of spindle or generator rotor.

Each of the three power houses is equipped with a 100-ton bridge crane that has a 15-ton auxiliary hook. These cranes were first used to install the turbines and are now used in maintenance work. They have operator's cabs in the conventional position —just below the beams and on one side. This position has several disadvantages; (1) sometimes the operator cannot see the hook and the signal must be relayed through a second man, (2) in the summer time, the temperature sometimes reaches 130 F. in the cab from the heat rising off the turbine floor.

With the elimination of these disadvantages in mind, a set of pendant type controls were installed on one of the cranes and now it can be operated from the turbine floor (See Figure 2—the operator is the second man from the left and holds the controls in his hand). They have served the purpose for which they were intended by allowing the operator to get nearer the lift and moving him down to the turbine floor where it is cooler. In addition, they have caused a saving in manpower. Now one of the two riggers on the job operates the crane and no one is required in the cab of the crane.

**Small Turbine Overhaul**—Small turbine maintenance is much the same as that of the larger turbines. Through periodic inspections and thorough overhauls many instances of impending trouble have been averted. Costly equipment failure and production loss have been prevented.

Within both plant areas are over 100 small turbines ranging in size from the small 15-horsepower turbines up to the larger 1250-hp machines. In this group are machines of six of the major manufacturers with as many or more different types of designs. A program of scheduled maintenance has been followed for these machines and with good results. They are opened once a year for inspection and overhaul, and this is usually in the fall or winter when water temperatures are down and some of these cooling water pumps and turbines are on standby.

An overhaul is initiated by the production plant to whom the turbine belongs by sending a work order to the area engineer. He is responsible for the coordination of maintenance work for that plant. He in turn directs the work order to that shop—machine, pipe, boiler, etc.—concerned. Should more than one shop be involved, then sub-orders are written from the original work order to all shops having work to perform. The Machine shop received the work order in the case of a turbine overhaul as most all the work is machinist's work.

Before the machine is taken down, a set of vibration readings are taken. Later after the machine has been dismantled, the spindle is carried to the shop where all soluble deposits are washed away with water. If some of the deposits are insoluble, the spindle is sent to the sandblast yard where it is blasted with the same silica abrasive as used on the large spindles.

After having been cleaned, the blades and shrouds are checked for any defects. In most cases, they are checked by the magnetic particle method. The steam balance holes are also checked closely, especially those in wheels operating at very high speeds. These are checked thoroughly with micrometers for any signs of radial elongation.

All small turbine spindles are placed between centers in a lathe and checked for bent shafts. This has been found to be a worthwhile practice because if any unbalance is found at the time of the balance check this possibility has already been eliminated. While in the lathe, those bearing journals considered bad enough to need repair are turned down, metallized and turned or ground back to the original diameter.

After all blade, shaft and journal inspections and repairs have been made, each spindle is placed in a balancing machine and given a dynamic balance check. Any out of balance conditions found are corrected. These checks have proved to be worthwhile as most machines have less vibration and much of the field balancing has been eliminated. The balancing machine was designed and built in the Dow Shops and has proven satisfactory. (Figure 3).

The control mechanism is dismantled and checked for wear. This inspection includes the speed governor, control valve, overspeed trip valve and all linkage. Any parts found worn badly are replaced.

When the turbine has been re-assembled, it is brought up to speed with the drive coupling disconnected and the governor adjustments made. These governor adjustments include checking the overspeed trip.

The last and one of the most important duties of the Maintenance department is to write a complete report of the overhaul. This will include the as-found condition of the turbine proper and all auxiliaries, that corrective action taken, and that routine inspection work performed. Also included within the report is a list of those spare parts on hand that were used and a list of those parts that in the opinion of the maintenance personnel will be needed for the next overhaul. With this information, the operating and maintenance personnel can schedule and plan the next overhaul with an even greater degree of accuracy. ##

MAINTENANCE

Preventive maintenance for . . .

# Power Relays and Circuit Breakers

**Here's how a program was developed to avoid downtime resulting from power outage.**

RELAY MAINTENANCE REPORT

Inspected by: _____ Date: _____
Location: _____
Circuit: _____ Volts: _____ Phase: _____
Relay Make: _____ Type: _____

| | Calculated Settings | Relay as Found | Relay as Left |
|---|---|---|---|
| **Overcurrent Relays** | | | |
| Pick Up (amps.) | | | |
| Time Lever | | | |
| Time at 1000% (sec.) | | | |
| **Instantaneous Relays** | | | |
| Pick Up (amps.) | | | |
| Time at 140% (sec.) | | | |
| Overall Time (sec.) | | | |
| **Thermal Relays** | | | |
| Setting in % | | | |
| Setting in Amps. | | | |
| Time at 400% (sec.) | | | |
| **Undervoltage Relays** | | | |
| Hi Voltage Contact (volts) | | | |
| Lo Voltage Contact (volts) | | | |
| Time Full Voltage to 0 Voltage (sec.) | | | |
| **Time Delay Trip** | | | |
| Pick Up (amps.) | | | |
| Valve Setting | | | |
| Time at 400% (sec.) | | | |
| **General Condition of Relay:** | | | |

**Remarks:** _____

FIGURE 1—Form used to record daily work performance on relay maintenance.

Refinery electricians testing the time, overcurrent and instantaneous relays on a 2300-volt feeder circuit breaker.

**Charles T. Fisk**
The Standard Oil Company (Ohio)
Cleveland

TWO COSTLY electrical power outages, from faulty relay coordination, crystalized action on preventive measures. A program for testing, resetting and coordination of relays was organized.

Since Sohio did not have enough trained personnel experienced in relay work, it was necessary to employ the assistance of the local power company. Sohio personnel observed and took part in the program whenever possible, so that personnel would be available to handle relay work in the future.

Since this particular program was the first in the company, there was no past experience to use in determining test standards. Thus it was necessary to arrive at them as the program progressed. However, in all cases, the tests made and the data taken were sufficient to assure that the equipment was working satisfactorily. In several instances faulty relay operation and incorrect relay settings were found and corrected. At the conclusion of the program a detailed report of the results along with some recommendations was made. A few of the recommendations are as follows:

1. That the procedures of testing relays and associated switchgear be reviewed.
2. That a training program for personnel to do relay testing be instituted on a definite schedule.
3. That certain changes be made in the testing equipment.
4. That certain conditions in existing equipment be corrected.
5. That circuit breakers associated with the relays be checked at the earliest possible date.

This report, along with recommen-

**RELAY AND CIRCUIT BREAKER MAINTENANCE SCHEDULE**

**September, 1954**

| Circuit | Location | C/B Type | Relay Type | C/B Tested | Relays Tested |
|---|---|---|---|---|---|
| | | (No. 2 Cat Cracker Shutdown) | | | |
| TCC No. 2 Lift Blower | TCC Switch-gear Room | Oil | Thermal, Inst., Undervoltage | | |
| | | (Boiler House and Emulsion Plant Shutdown) | | | |
| CUV-4-CUTP 11 kv | Crude Unit Vault | Oil | Overcurrent, Inst. | | |
| CUV-2-Air Comp. | Crude Unit Vault | Air | Thermal, Inst. | | |
| CUV-3-BHP | Crude Unit Vault | Air | Overcurrent | | |
| CUV-4-BWTP | Crude Unit Vault | Air | Overcurrent | | |
| Emulsion Plant | BWTP Vault | Oil | Time Delay Trip | | |
| Boiler House | BWTP Vault | Oil | Time Delay Trip | | |

**FIGURE 2—Form used for scheduling preventive maintenance inspection of electrical relays and circuit breakers.**

**CIRCUIT BREAKER MAINTENANCE REPORT**

**Inspected by:**____ **Date:**____
**Location:**____
**Circuit:**____ **Volts:**____
**Make:**____ **Type:**____ **Serial No.:**____

**GENERAL CONDITION**

Contacts:____
Arc Ruptors:____
Operating Relay:____
Mechanical Linkages:____
Cubicle:____
Others:____

**Operating Time:** **Phase 1** **Phase 2** **Phase 3**

**FOR OIL CIRCUIT BREAKERS ONLY**

General Condition of Oil:____
Oil Dielectric Strength:____
Oil Added:____ Filtered:____ Changed:____ Amount:____
Oil Dielectric Strength after filtering or changing:____
Remarks:____

**FIGURE 3—Form used to record daily work performance on circuit breakers.**

dations, is the basis for the relay and circuit breaker testing and maintenance program which now exists at No. 1 Refinery.

The first step taken as a result of the report was setting up a training program. Two refinery electricians were selected to be trained for relay inspection and testing. Eight weekly classes of two hours duration were decided on. Since this is the first place that a new man comes into contact with relay work, it is very important that the sessions be well planned. Generally the training was divided into three sections; namely, instruction on relay, theory, design and testing procedures; explanation of, and instruction on the use of the relay testing equipment; and practice setting and testing of relays.

It is important that the practical electrician receives sufficient instruction to know what he is doing and why he is doing it. The larger portion of time should be spent practicing setting and testing the relays, for this work is still something of an art and there are no cut and dried rules. Instruction on the operation of each type of relay found in the plant along with the opportunity to practice setting and testing it was given each man before he was asked to service a relay in the field. The amount and complexity of the relaying found in the plant should determine to a large extent the amount of training necessary.

The next step was to develop a testing and maintenance schedule. From the results of the work done in the first relay inspection and testing program it was decided that a two year schedule would be tried. At this time it was also decided that a circuit breaker maintenance schedule should be drawn up to run concurrently with the one for relays due to the close association of the two pieces of equipment. After all, it seemed inconsistent to have the relay all polished up and working perfectly and then have its circuit breaker fail to operate properly.

Figure 2 shows a section of that two year schedule. In order to reduce the amount of paper work for the electrical foreman, this is the only record which he is required to keep. When a relay or circuit breaker has been serviced he has only to write the date on the schedule. This serves as a guide in controlling and planning his work by telling him what work he has done, and what work he has yet to do. It should be noted that the various circuits are scheduled only by months. This was necessary to provide some flexibility in taking the various circuits out of service.

Although it is not necessary to remove a circuit from service while checking the relays, it is necessary in order to service the circuit breaker. On circuits where it is necessary to return them to service in the shortest time possible, the relays are checked with the circuit in service and it is only shut down long enough to inspect the circuit breaker. Whenever possible the relay and circuit breaker servicing is coordinated with the scheduled processing unit inspection shutdowns to minimize lost production time.

Figure 1 is a sample of the relay inspection form which is now being used. It was our purpose to produce a single form which could be used for all types of relays found in the refinery. Since few men in the field like to spend a lot of time writing, we have tried to make it as short and simple as possible and still provide all of the necessary information.

At the top of the form, space is provided for that information which is necessary to indentify the relay to be serviced. This includes the location, circuit, operating voltage, which phase the relay is in, the make of the relay, and type. Below this information are listed the five types of relays found in the refinery. For each type of relay, three sets of data are compiled. These are: 1—the calculated setting, or those at which the relay is supposed to be operating, 2—the conditions under which the relay actually operated when it was tested, and 3—the conditions under which the relay operated after any necessary adjustments were made. At the bottom of the form space is provided to note the general condition of the relay. This should include dirtiness, any broken or worn parts, or any part which was discovered to be inoperative. Space is also provided to comment on any unusual circumstances which were encountered or adjust-

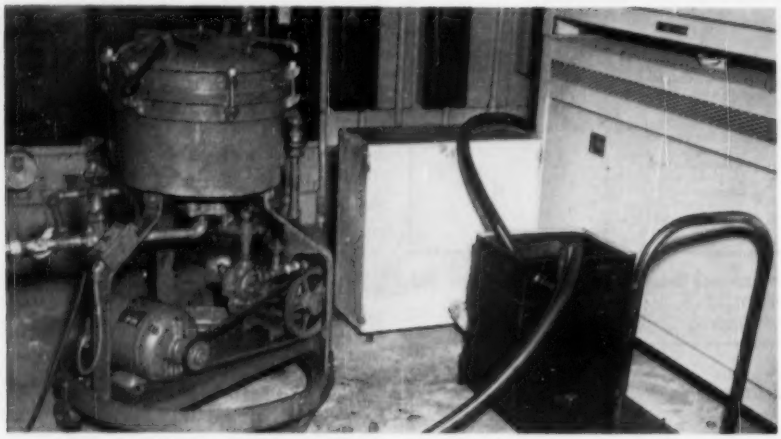

FIGURE 4—Portable filter set up to clarify breaker oil.

ments which had to be made.

All calculations for original relay settings or for changes in relay settings are made by the utilities engineer. At the beginning of each month he sends to the electrical foreman the forms which will be required for the testing to be done that month. On each form is listed the description of the relay to be tested along with the data under calculated settings. After the electrician has completed his testing, he lists the results under the proper heading and returns the form to the Utilities Engineer. At the present the forms are kept in note-book form.

In conjunction with the relay testing program, a relay card file is being compiled. In this file a card for each individual relay is kept. On each card is recorded the pertinent information concerning the relay such as location and service, manufacturer, model and type, current ratings, CT ratio, and instruction and parts bulletin number.

As it was stated before, the circuit breaker maintenance program was designed to run concurrently with the relay program. Here again it was attempted to devise a report form which would be applicable to all types of breakers in the refinery. It too was made as simple as possible and still supply the desired information. The top portion of the form (See Figure 3) is devoted to identification of the circuit breaker. This includes the location, circuit, operating voltage, manufacturer, type, and serial number. The next portion lists some of the points which should be checked on all types of circuit breakers. These include the contacts, arc ruptors, operating relay, mechanical linkages, and the general condition of the cubicle. Any adjustments or servicing along with the general condition of the particular element are listed. The recommendations and instructions for maintenance as listed by the manufacturer in his instruction book are followed rather closely. After the breaker has been thoroughly cleaned and inspected the operating time is recorded.

The last section of the form concerns only oil circuit breakers. The dielectric strength of the oil in each circuit breaker is tested. The method used is that which is listed by ASTM. Depending upon the condition of the oil, it is either filtered (Figure 4), changed or left alone. If the oil tests 17.5 KV or less it is filtered. New oil must test at least 26 KV. If the oil level is low, the necessary amount is added and recorded on the form. The dielectric strength requirements for the oil are based on the recommendations of circuit breaker manufacturers.

The procedure for handling the circuit breaker report forms is the same as that for the relay forms. At the beginning of each month the forms for the circuit breakers which are to be tested are sent to the electrical foreman. After the circuit breakers have been inspected, the forms are returned to the utilities engineer where they are filed in notebook form.

A card file is also being set up for circuit breakers. Here is recorded such pertinent information as location and service, manufacturer, type, serial number, voltage and current ratings, interrupting capacity, oil capacity, and instruction and parts bulletin numbers. Whenever it is available all the information on the solenoid operating mechanism is also recorded.

As yet the relay and circuit breaker maintenance program is still in its infancy, and it is realized that some revision probably will be necessary. However, management now has some assurance that if a short circuit occurs within our system, the proper circuit breaker will operate and an entire unit will not be shut down unnecessarily. The job now is to keep things that way and it is believed that the maintenance program will accomplish this. The goal is zero outages per year due to faulty relay or circuit breaker operation.

In setting up a relay and circuit breaker maintenance program such as the one at Sohio's No. 1 Refinery, several points should be kept in mind.

1. Have a complete knowledge of the components and characteristics of the electrical system. A comprehensive survey may be necessary.
2. Develop testing standards and procedures.
3. Set up a training program for the men who are to do the work.
4. Prepare a schedule which will satisfy conditions found in the plant.
5. Devise a simple method of recording the test and inspection data.
6. Be receptive always to any changes or adjustments to the program which will assist in attaining the goal of zero outages per year due to faulty relay or circuit breaker operation. ##

**Meet the Author**

CHARLES T. FISK has been with The Standard Oil Company (Ohio) since his graduation from Ohio Northern University, with a degree in electrical engineering, in 1952. He is now utilities engineer at the company's No. 1 refinery in Cleveland, with responsibility for engineering the development and maintenance of all the plant's utilities.

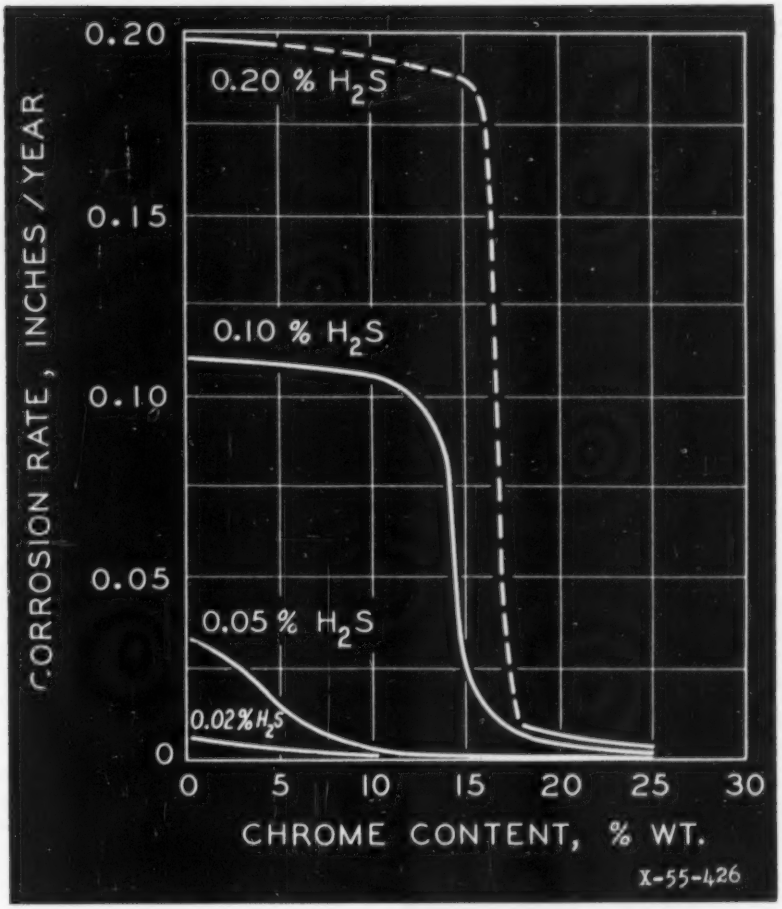


FIGURE 1—Corrosion rate of chrome steels in $H_2S$ at 1175 F and 175 psig hydrogen pressure.

# What Happens in $H_2$-$H_2S$ Corrosion

**The effect of hydrogen-hydrogen sulfide at elevated temperatures has shown the need of the studies reported here.**

**E. B. Backensto, R. D. Drew, C. C. Stapleford**
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IT HAS LONG been known that when hydrogen sulfide corrodes carbon and low chrome steels an iron sulfide corrosion scale is formed. The literature on the effects of hydrogen sulfide and hydrogen separately is voluminous. Limited information is available on the combined effects of hydrogen-hydrogen sulfide.[1,2]

Hydrogenation plant experiences served as a forewarning of the seriousness of this problem in catalytic reformers. Nelson[3] defined the sulfide scaling problem and indicated the need for high chrome alloys. But, on the other hand, the petroleum industry had considerable experience in using low chrome steels without difficulty in fractionation, catalytic and thermal cracking, and thermal reforming equipment. Therefore, when designing catalytic reformers, economics appeared to favor low chrome steel construction, since the seriousness of sulfide corrosion was not fully understood.

A laboratory program was initiated to study the corrosion resistance of various steels in hydrogen-hydrogen sulfide atmospheres. This program included tests in commercial reforming units, in laboratory pilot units utilizing hydrogen, and in laboratory corrosion units. After each test the coupons were descaled and weighed; the metal weight loss was used to calculate the corrosion rates, which are expressed as inches of penetration per year.

If the sulfide scale is affixed tightly to the metal walls, it may offer some resistance to further corrosion. If, however, the scale is jarred loose by any means, or flakes off during shutdowns due to differences in thermal expansion of the scale and metal, the exposed fresh metal is again susceptible to rapid corrosion, and the dislodged scale may cause serious pressure drop difficulties and, ultimately, plugging.

Typical corrosion rates of chrome steels in hydrogen-hydrogen sulfide atmospheres at 1175° F and 175 pounds per square inch gage are shown in Figure 1. The corrosion rate is plotted against the chrome content of the test metals; the lower numbers represent straight chrome steels, while the high chrome contents represent chrome-nickel alloys of 18-8, 25-12, and 25-20. The corrosion rates increase with $H_2S$ concentration, particularly for the low chrome steels. The rate curves usually drop off rapidly in the 7-16 percent chrome range.

The same type of data for 985° F and 485 psig are shown in Figure 2.

Tests were made at very low hydrogen sulfide concentrations to determine the minimum concentration that would cause scaling. A thin film of powdery corrosion products appeared on steels containing up to 2¼ percent chrome at 0.006 percent vol. $H_2S$; this type of corrosion was evident for all steels containing up to 9 percent chrome at 0.01 percent vol. $H_2S$. In no case at the low concentrations was there evidence that scale would form on the chrome-nickel

alloys. From observations in the laboratory, flaky corrosion scale generally forms on steels which exhibit corrosion rates of about 0.01-0.02 inches per year or higher, regardless of chrome content. Generally the scale is less flaky and more tightly adhering for the high chrome alloys.

Typical corrosion test results are shown in Table 1. In this test the effluent gases from the pressure bomb were passed through a second bomb maintained at atmospheric pressure. Note the good agreement in the corrosion rate results for the group of 0-7 percent chrome steels and the group of chrome-nickel alloys.

In laboratory tests, exposure time of test coupons is extremely important when attempting to obtain practical corrosion rate data. Figure 3 is a plot of corrosion rates for 0-9 percent chrome steels vs. exposure time. Each point on this plot represents an individual test, not single rate measurements on the same coupon at different exposure times. The corrosion rate is high after 24 hours and drops off rapidly to about 100 hours; thereafter, the rate drops off slowly. This shows that the sulfide scale offers some protection against further corrosion. Most of our laboratory tests, unless specified, have been 150-200 hours duration, however, tests at very low $H_2S$ concentrations were generally longer—about 400-500 hours. It is felt that the data obtained in this manner show conservatively high corrosion rates.

Since, in the operation of refining processes, a wide variety of conditions are encountered, it becomes important to know the effect of the major variables on sulfide corrosion. According to data in Figures 1 and 2, the corrosion rate increases with $H_2S$ concentration. This same effect is shown in Table 2 for $H_2S$ partial pressures from 0.25 to 1.0. Tempera-

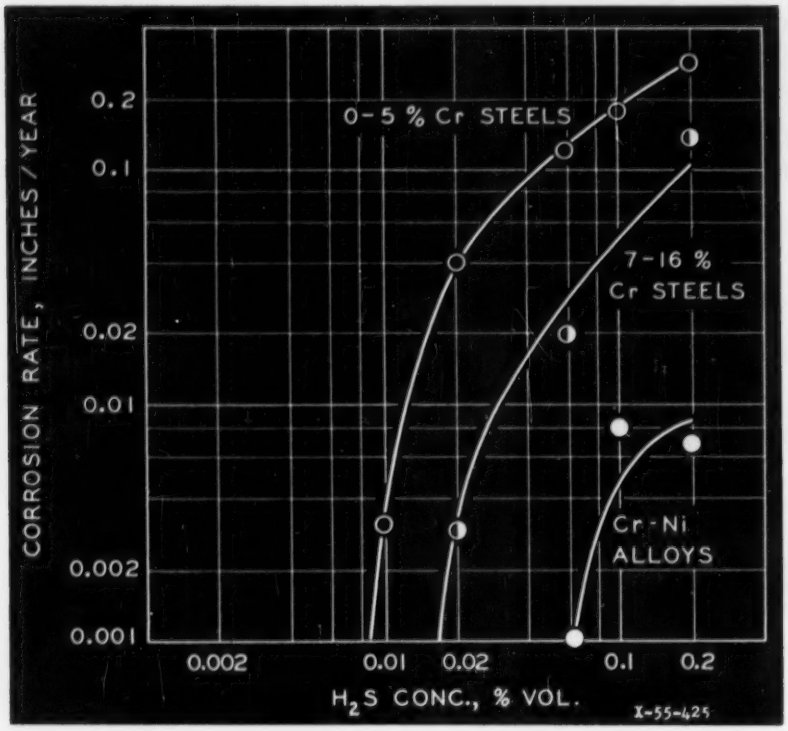


FIGURE 2—Effect of $H_2S$ concentration on corrosion rate at 985° F and 485 PSIG hydrogen pressure.

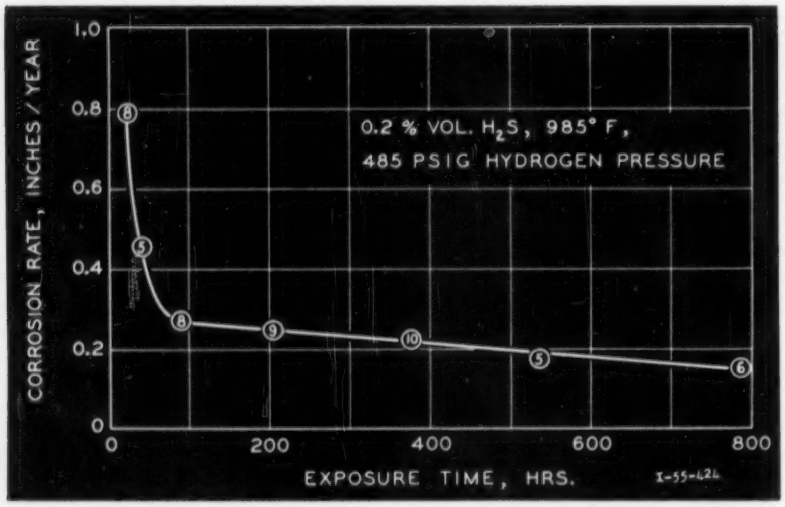


FIGURE 3—Effect of exposure time on corrosion rates of 0-9% chrome steels (The number of individual measurements averaged is shown within the circle).

**TABLE 1**
**Typical Corrosion Test Results**

| | | |
|---|---|---|
| Average Conditions: | | |
| Temperature, °F | 850 | 850 |
| Hydrogen Pressure, psig | 0 | 485 |
| $H_2S$, Percent Vol. in $H_2$: | | |
| Inlet | 0.087 | 0.111 |
| Outlet | 0.081 | 0.087 |
| Length of Test, hrs | 224 | 224 |
| Material Tested | Corrosion Rate, Inches Per Year | |
| Carbon Steel—ASTM A7 | 0.0351 | 0.107 |
| Carbon Steel—ASTM A-83-A | 0.0494 | 0.127 |
| Carbon Steel—ASTM A-201-A | 0.0415 | 0.095 |
| 1 Cr—½ Mo | 0.0400 | 0.117 |
| 2¼ Cr—1 Mo | 0.0394 | 0.108 |
| 5 Cr—½ Mo | 0.0376 | 0.0918 |
| 7 Cr—½ Mo | 0.0343 | 0.0988 |
| 12 Cr—Type 405 | 0.0238 | 0.0178 |
| 12 Cr—Type 410 | 0.0234 | 0.0239 |
| 16 Cr—Type 430 | 0.0146 | 0.0154 |
| 18-8—Type 302 | 0.0041 | 0.0074 |
| 18-8—Type 304 | 0.0034 | 0.0052 |
| 18-8—Type 304L | 0.0032 | 0.0059 |
| 18-8—Type 347 | 0.0031 | 0.0056 |
| 25-12—Type 309 | 0.0031 | 0.0025 |
| 25-12—Type 309CBS | 0.0022 | 0.0022 |
| 25-20—Type 310 | ..... | 0.0018 |

**TABLE 2**
**Effect of $H_2S$ Partial Pressure On Corrosion Rate**
**(24 Hr Tests @ 985° F)**

| $H_2S$ Part. Pres., psi | 0.25 | 0.5 | 0.5 | 1.0 |
|---|---|---|---|---|
| Total $H_2S$ & $H_2$ Pressure, psig | 235 | 485 | 235 | 485 |
| Materials | Corrosion Rate, Inches per Year | | | |
| 0-5 Percent Cr | 0.49 | 0.64 | 0.63 | 0.81 |
| 7-16 Percent Cr | 0.36 | 0.46 | 0.49 | 0.58 |
| Cr-Ni | 0.07 | 0.06 | 0.07 | 0.07 |

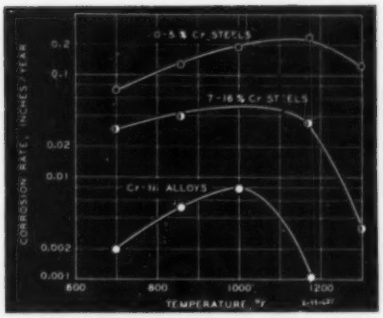


**FIGURE 4—Effect of temperature on corrosion rate at 0.1% Vol. $H_2S$ and 485 PSIG hydrogen pressure.**

ture is another important variable as shown in Figure 4.

A three-week run was made in the laboratory to simulate naphtha furnace conditions by pumping a mixture of Kuwait naphtha vapor, 0.085 percent vol $H_2S$, and 11.1 percent vol $H_2$ through a 5 percent chrome tube in a gas-fired furnace. During this test the 5 percent chrome tube formed scale nearly $\frac{1}{64}$-inch thick. This scale analyzed 62 percent iron which means essentially iron sulfide and no coke. Photographs of furnace tube sections in Figure 5 show the flakiness of the scale after cooling.

Gas velocity often has an important effect on corrosion rate; however, in all of our studies of hydrogen sulfide corrosion we found no significant differences in corrosion rate due to gas velocity over a wide range.

The question of hydrogen blistering always arises when dealing with corrosion in hydrogen atmospheres. Under the conditions covered in our study, however, this does not appear to be a major problem.

From the previous discussion it appears that there are two possible ways to minimize hydrogen sulfide corrosion; the choice depending on economic considerations. One is the use of chrome-nickel stainless steels. Another is the reduction of $H_2S$ concentration in the environment, for example by desulfurization of the charge stock to the process or by removal of $H_2S$ from recycle gas streams. A third method is the protection of metal surfaces by coating with aluminum.

A run was made at 0.2 percent vol $H_2S$, 1200° F., 175 psig hydrogen pressure, for 18.2 days to test various aluminum coatings. The following types of coatings were included in this test:

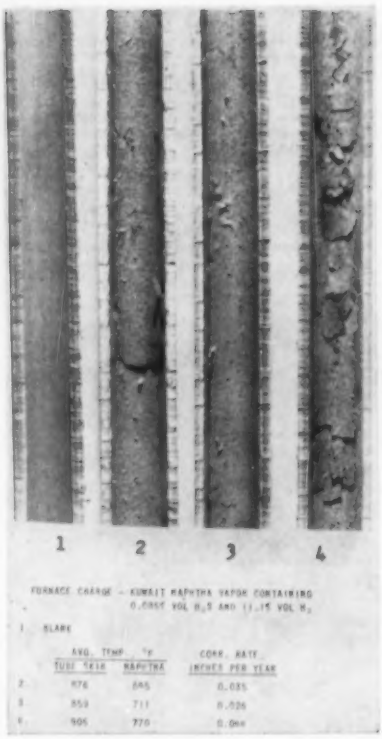


**FIGURE 5—Furnace tube (B & W Croloy 5⅜" SCH. 40) sections after 3-week test at 460 PSIG**

- Calorized (an aluminum diffusion process) carbon steel.
- Several aluminum dipping processes on carbon steels and steels containing up to 7 percent chrome.
- Metallized aluminum of different thicknesses on a low chrome steel.

At these conditions only calorized carbon steel showed no attack. The aluminum overlay and most of the bond material disappeared for the metallized and aluminum dipped specimens.

In addition to the conditions cited above, calorized specimens showed no apparent attack after 55 days exposure to 0.5 percent vol $H_2S$ at 935° F. and 175 psig hydrogen pressure. At lower $H_2S$ concentrations, for test periods as long as 33 days, this type of coating has been satisfactory up to 1000° F. and 500 psig hydrogen pressure. Figure 6 shows photomicrographs of calorized carbon steel specimens exposed to different corrosive atmospheres. This information shows the importance of maintaining a continuous coating if calorizing is expected to give satisfactory service in $H_2$-$H_2S$ atmospheres.

Laboratory tests of less than 10 days have shown that aluminum dipped carbon steel shows no visible attack for conditions up to 1000° F. and 500 psig hydrogen pressure. At the same conditions, longer term tests (of 20-35 days), however, showed that the aluminum overlay disappeared. Figure 7 shows photomicrographs of aluminum dipped carbon steel specimens exposed to different corrosive atmospheres. The photo on the left shows no attack under the test conditions for a relatively short term test. The photo on the right shows nearly complete loss of overlay and bond material. The grain growth

## Meet the Authors

Stapleford Drew Backensto

CARVEL C. STAPLEFORD, a research associate for Socony Mobil Laboratories, has been with the company at Paulsboro since 1935, except for some five years spent with the Army Chemical Corps, supervising the manufacture of war gases. Stapleford is a chemical engineering graduate from North Carolina State College.

ROBERT D. DREW is a research associate with Socony Mobil Laboratories at Paulsboro, N. J. With the research organization since 1939, Drew joined Socony Mobil, shortly after completing a degree in chemical engineering at Yale University. Now assigned to the laboratories' Process Development section, he heads an Engineering Studies group.

E. B. BACKENSTO, a senior engineer with Socony Mobil Laboratories, has held a variety of research positions since joining the company at Paulsboro in 1943. During that time, he has served as a group leader in charge of light-products treating and refining and in the development of reforming catalysts. He presently is engaged in corrosion studies. Backensto holds a B.S. degree in chemical engineering from Lehigh University.

noted at the high temperature may have contributed to the failure of the coating.

This is an abstract of the paper first presented at the Regional NACE meeting, Houston, October 21, 1955.

ACKNOWLEDGMENT

The authors wish to express their appreciation to J. E. Prior, of Socony Mobil laboratories, who conducted the metallographic examinations in connection with this work.

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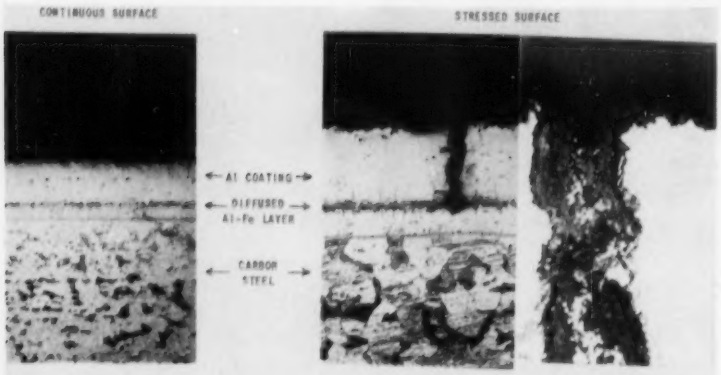
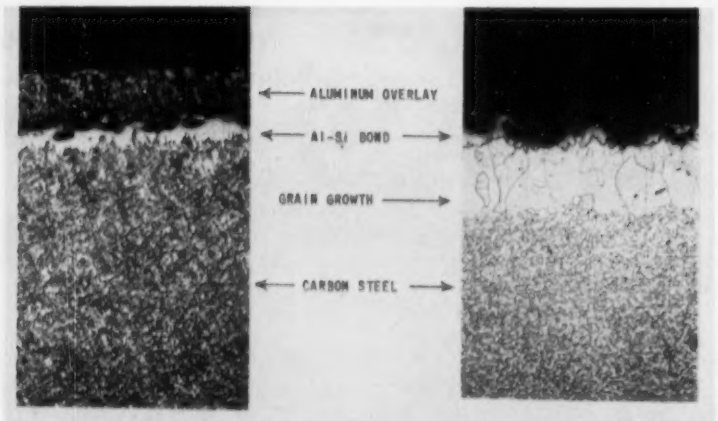

CONTINUOUS SURFACE
STRESSED SURFACE
Al COATING
DIFFUSED Al-Fe LAYER
CARBON STEEL
50X - NO APPARENT ATTACK OF COATING SHOWN
100X - NO APPARENT ATTACK OF COATING SHOWN; CRACK EXTENDS NEARLY TO BASE METAL
250X - ONE OF THE OTHER CRACKS IN THE SAME SPECIMEN SHOWING CREVICE FILLED WITH CORROSION PRODUCTS

| AVERAGE TEST CONDITIONS | CONTINUOUS SURFACE | STRESSED SURFACE |
|---|---|---|
| $H_2S$, % VOL IN $H_2$ | 0.046 | 0.024 |
| TEMPERATURE, °F | 985 | 985 |
| HYDROGEN PRESSURE, PSIG | 485 | 485 |
| EXPOSURE TIME, HRS. | 178 | 158 |

**FIGURE 6—Photomicrographs of ~~calorized~~ carbon steel specimens exposed to different corrosive atmospheres.**




| AVERAGE TEST CONDITIONS | LEFT PHOTO | RIGHT PHOTO |
|---|---|---|
| $H_2S$, % VOL IN $H_2$ | 0.20 | 0.10 |
| TEMPERATURE, °F | 985 | 1175 |
| HYDROGEN PRESSURE, PSIG | 485 | 175 |
| EXPOSURE TIME, HRS. | 77 | 154 |

**FIGURE 7—Photomicrographs of aluminum dipped carbon steel specimens exposed to different corrosive atmospheres.**

# Discussion

**Heinrich Heep**
The M. W. Kellogg Company

High temperature hydrogen sulfide corrosion is a very timely subject of wide interest. The authors and company with which they are connected have made a real contribution to the petroleum industry in publishing this excellent paper.

Valuable information is presented on corrosion rates of the most used analyses of steel in atmospheres of different concentration of either hydrogen sulfide or of hydrogen sulfide and hydrogen and under variations of pressure, temperature and length of exposure. Test results provide useful information for those generally interested in this type of corrosion. In particular, conditions characteristic of catalytic reforming processes were simulated in the tests and interesting data derived.

Of special interest among the conclusions in the paper is the experimental corroboration of the fact that corrosion resistance against hydrogen sulfide is raised in a stepwise, rather than proportional, fashion as the percentage of chrome in steel is increased. Thus the low chrome and chromemoly steels do not possess better resistance to $H_2S$ corrosion than carbon steel and one has to go to the 12 to 16 percent Cr. group to appreciably lower the corrosion rates.

The reviewer feels that the tables and graphs fail to present comparative data on steel with various types of protective aluminum coatings. Have such data been collected or did the authors derive their qualitative conclusions regarding the value of these protective coatings from microphotographs as depicted in Figures 6 and 7? If the latter is the case the validity of the conclusions must be questioned, since those photographs seem to have been misinterpreted.

For instance, Figure 7 shows a sample of aluminum dipped carbon steel after 77 hours exposure. Approximately 0.010 inch metallic aluminum remains bonded to the steel by means of a layer of about 0.0025 inch iron-aluminum alloy. The reviewer estimates from the small thickness of the diffused layer that 2½-5 percent Al-Si alloy was used in the preparation of the sample. Silicon is a deterrent to diffusion and consequently, a thinner metallurgical bond results as compared with the use of pure 99 plus aluminum. Another dip-coated specimen shown in Figure 7 experienced an 154 hours exposure at 1175 F. Most of the aluminum overlay is diffused into the steel as indicated by the growth of the iron-aluminum diffusion zone. However, the authors misinterpreted this as grain growth and complete removal not only of the aluminum overlay, but also of the diffused layer, leaving the bare steel unprotected. The reviewer believes that the photos actually show a diffused aluminum coating comparable to a calorized surface as shown in Figure 6. The reviewer also disagrees with the explanations of Figure 6. For instance, the approximately 0.015 inch layer described as aluminum coating actually is diffused iron-aluminum alloy characteristic of calorized surfaces. Such aluminum overlay, if it existed, would be ductile and unlikely to crack in the fashion shown on the right.

It is the brittle alloy which tends to crack.

In essence the reviewer believes that the photo-micrographs disprove the unfavorable conclusions of the authors regarding hot-dip aluminum coatings, which also do not agree with field experiences. In this connection, the reviewer wishes to mention that more than 1000 feet of hot-dip aluminum coated pipe engineered and installed by his company during their construction of the Ultraformer for American Oil Company in Texas City. After being on stream approximately 2100 hours, the aluminized surfaces appear to be standing up well against $H_2S$-corrosion, while unprotected surfaces, although subjected to a less corrosive condition, are badly attacked.

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**Elmore M. Peloubet**
Arthur Tickle Engineering Works, Inc.

In this referenced paper, the authors refer to Figure 7, showing a photo-micrograph of aluminum dipped carbon steel specimens which were exposed to hydrogen sulfide corrosion at elevated temperatures. Their interpretation of these photomicrographs is that the aluminum has been completely corroded away leaving the base steel exposed to attack of the hydrogen sulfide. They refer to a layer which they term "grain growth."

It is my opinion that this is a complete misinterpretation of the photo-micrograph. I believe that this so-called "grain growth" area is actually the diffused layer of intermetallic iron aluminum alloys which has resulted from the aluminum overlay diffusing into the base steel.

The formation of this diffused bond layer or interfacial layer will vary according to many factors, namely, the times and temperatures of the aluminum dipping operation, the type of steel being dipped, and the aluminum alloy which is used for the aluminum dipping operation.

The temperature range in which the authors conducted their investigation is suitable for causing this transformation of the free aluminum overlay into the diffused interfacial bond layer consisting of the complex intermetallic compounds of iron and aluminum. Naturally the degree of this transformation will depend upon the time and temperature of the actual operation. In the case as being studied by the authors the temperature as mentioned in the text and under Figure 7 of 985 F. and 1175 F. and the hours of exposure are 77 and 154, respectively will be sufficient to cause this diffusion to occur.

I would be particularly interested in knowing whether the authors actually determined whether there was any corrosion of the base steel itself after they believed the aluminum overlay had disappeared as shown on Figure 7. In other words, did they attempt to determine the amount of corrosion on the base steel by measurement of weight loss or did they merely believe that corrosion had occured due to the disappearance of the shiny characteristic color of the aluminum coating had disappeared and all of the beneficial effects of an aluminum coating had disappeared with it.

In other words, was the test sufficient to indicate that with the disappearance of all the aluminum and the appearance of this so called "grain growth" area as indicated in Figure 7 definite indication that corrosion would occur or was not sufficient data obtained by further exposure to confirm this assumption.

Another important point for the discussion of the protection of steels to high temperature hydrogen sulfide corrosion by hot-dip aluminizing is the consideration of the aluminum alloy actually used for the application of the coating. It has been definitely established that the addition of certain elements to an aluminum bath will reduce the formation or act as a barrier to the formation of this intermetallic alloy layer. One of the most effective such additives is silicon. The use of silicon in the hot-dip aluminizing bath not only effectively decreases the formation of the intermetallic layer during the actual hot-dipping process, but it also continues its effectiveness in reducing the formation of the diffused layer obtainable by subsequent high temperature heat treatments which are conducted in order to purposely establish this diffused layer.

We have found that the use of silicon in the aluminum bath has a barrier effect, it is recommended by us to any prospective user of hot-dip aluminized coatings in the petroleum field for the protection of steels to the attack of hydrogen sulfide that they use commercially pure aluminum with a definite maximum limit on silicon contact.

We do not know whether or not these particular specimens as tested by the authors were formed from an aluminum silicon alloy, but we must assume this in as much as in Figure 7 of the referenced paper, they refer to the Al-Si Bond.

In the connection with the use of the aluminum silicon alloy, the transformation of the overlay and the actual bond layer as obtained during the dipping operation, into a completely diffused layer will take place more rapidly at a lower temperature than if pure aluminum had been used for the hot-dip coating. Likewise, the closer the actual operation temperatures at 1200 F. the more rapidly the aluminum silicon overlay will diffuse.

This is due to the fact that the aluminum silicate eutectic will actually be molten at temperatures in the neighborhood of 1100 F. Under the conditions of the tests conducted by the authors, I would definitely suspect that at the 1175 F. test conditions the aluminum silicon alloy actually was in a molten condition. As stated before, this would definitely tend to increase the rapidity with which the diffusion would occur and naturally would result in disappearance we quote of the aluminum overlay.

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# Comment

### By the Authors

We appreciate the comments by Peloubet and Heep. Since both men raise similar questions, we shall attempt to clarify our results.

The supplier of the aluminum dipped specimens was familiar with our problem and that these test pieces would be run in an $H_2$-$H_2S$ atmosphere. We were told that these contained a 12 percent Si-Al bond layer. We understand that in cooperation with the supplier our company arrived at a specification for aluminum dipped material of one mil bond and four mil overlay minimum thickness.

Perhaps the terms used in our paper to describe aluminum dipped specimens are not those generally accepted in the industry. We believe, however, that the terms used are clearly defined by pictorial reference.

What we called grain growth was just that regardless of how it came about. Since we did not test this growth area for aluminum, we could not definitely call this aluminum diffusion.

For calorized specimens we should not have referred to an aluminum overlay; we realize that calorizing is a diffusion process wherein the outer surface is richest in aluminum, with the aluminum content decreasing with depth. The notations on Figure 6 were for convenience in our evaluation.

The term "diffused Al-Fe layer" does not properly define this area. The dark line on the photomicrographs, which appears to be a needle-like crystalline structure, is probably an Fe-Al intermetallic compound. From our experience we have noted that this area shows up only after exposure to $H_2$-$H_2S$ at high temperatures.

We should point out that, for aluminum dipped specimens, the test pieces were cut from a larger aluminized plate, therefore, only two large faces of the coupon were coated, while base metal was exposed on all smaller sides.

Using this procedure, the test conditions are more severe. It was felt that such a test would represent extreme field conditions where it might be possible to break or impair the coating during fabrication of the unit. For calorized specimens, two mounting holes were drilled through a coated specimen, exposing base metal at these points.

Considering the way the specimens were prepared, there was no accurate way to measure base metal weight loss for the aluminum coated specimens. In our tests the disappearance of overlay and bond, by any means, was considered a failure. We arrived at this conclusion since in many cases where the overlay was no longer present after exposure, a film of corrosion product was present.

In one of our tests, two similar dipped specimens were included. One of these was cut for metallographic inspection and showed complete loss of overlay. The other specimen from this test was not examined metallographically but placed in another test run. After the second test period, the aluminum dipped specimen was scaled nearly to the extent of fresh carbon steel in the same test.

Further, we know of an actual commercial installation at intermediate temperature where in less than two months service the aluminum dipped coating spalled off and iron sulfide corrosion scale covered the base metal.

We appreciate knowing that hot dip aluminum coated pipe is showing good protection in reformer service. The reason this experience differs from ours may be due to the type of annealing or surface preparation used.

In a paper by Kremer and Volk on "Production and Use of Heat Resisting Aluminum Coating" (Stahl und Eisen, Vol. 66-67, pp. 250-255, 1947), it is pointed out that scaling resistance of hot-dip aluminized parts can be improved considerably by a diffusion heat treatment at 1900-2000 F.

The authors also point out that at high temperatures the aluminum diffuses into the base metal and decreases the effectiveness of the coating.

We feel that all types of aluminizing may find application in this field and we agree that our work suggests additional tests on aluminum coatings. We hope that our paper has pointed out the need for more information on these coatings, from both the suppliers and users.

Also, since there are many techniques for aluminizing, it would be extremely advantageous to have more information on the various types, their application in reformer service, their limitations of application, and the recommended methods of surface preparation and where and when these methods can be applied.

# Take a Look at 1956

**Oil demand will parallel the general economy, a 4½ percent step-up being expected in the U. S.; Outside U. S. the boost will be even greater.**

**Cecil W. Smith**
Petroleum Refiner Staff

PETROLEUM CONSUMPTION in the U. S. reached a new peak during 1955, and this year's outlook is even brighter as growth in the use of oil will continue. Not only in the U. S. will this be true, but the rest of the world is now expanding its reliance on oil at a considerably faster pace than is the U. S.

The fact that U. S. oil demand reached a new all-time high is not surprising, for each of the past 13 years has seen oil use increase over the previous period. The only unusual aspect was the fact that the nation's needs had reached and passed the three-billion-barrel mark, more than twice as much as was consumed annually immediately prior to World War II.

Estimates of 1956 U. S. consumption assume usage of an additional 150 million barrels of petroleum products over 1955's record level. Anticipated domestic demand averaging 8,750,000 barrels daily this year would top the 1955 rate of 8,375,000 barrels a day by 4.5 percent. Percentagewise, that would not be as great as the 8 percent hike experienced in 1955, but it will mark the return to a more normal annual gain.

**The sharper than average** increase in 1955 partly reflects the lag in demand in the preceding year. A smaller rise in domestic demand in 1956 would reflect a return to the historic pattern of growth for the industry, at between 3 and 5 percent.

Product inventories have been held in fairly good balance by the continuing gains in consumption rates. Recently, supplies of products were equal to about 60 days' consumption, compared with about 64 days a year earlier, and 61 days two years previous. Stocks of gasoline at primary levels (refineries, bulk stations, and in pipe lines) recently were about 2 percent greater than they had been a year ago, which reflected considerable improvement from the disproportionately high level that existed some months previously.[1]

Despite the high rate of refinery runs, which averaged about 7,500,000 barrels daily in October, or about 9 percent more than a year earlier, distillate heating oil inventories at primary levels held in fair balance relative to demand for this product which also rose 9 percent in the first nine months. Prices were raised in eastern areas late in November. Prospects for this product will depend greatly on the weather in the months ahead. Assuming normal temperatures, demand for light heating oils may increase about 9 percent on a year-to-year basis over the near term, reflecting the greater number of oil burners in use.[1]

Inventories of heavy heating oils were reduced in the past 12 months, and recently were about 19 percent below those a year earlier. Most of the improvement took place on the West Coast. Inventories in eastern areas have risen recently, but, with refineries continuing to reduce residual yields, expectations are that stocks of heavy heating oils will not become excessive.[1]

Improved price structure for refined products contributed to improvement in the spread between crude prices and refinery realizations in 1955. Refinery spreads recently were the best since late 1952. Provided refinery runs are held in line with consumption, refinery spreads should remain reasonably close to current improved rates.[1]

Historically, improved prices for petroleum products have been followed by periods of too high refinery runs, bringing oversupplies and weaker prices. The expected slight curtailment of imports is a strengthening factor in the crude oil price picture, coupled with the high rate of consumption. During the heating season, of course, the weather will have an important bearing on the supply-demand relationship, and on prices.[1]

Free world consumption of petroleum last year reached a new high for the 10th consecutive year since the close of the second world war. The U. S. still leads the way in

**Estimated Free World Petroleum Demand—1956**
(Thousands of Barrels Daily)

| | 1954 | 1955 | Percent Increase | 1956 | Percent Increase |
|---|---|---|---|---|---|
| United States | 7,752 | 8,375 | 8.0 | 8,750 | 4.5 |
| Other Free Areas* | 4,775 | 5,300 | 11.00 | 5,750 | 8.5 |
| Total Free World | 12,527 | 13,675 | 9.2 | 14,500 | 6.0 |

* Estimated by Standard & Poor's Corporation.

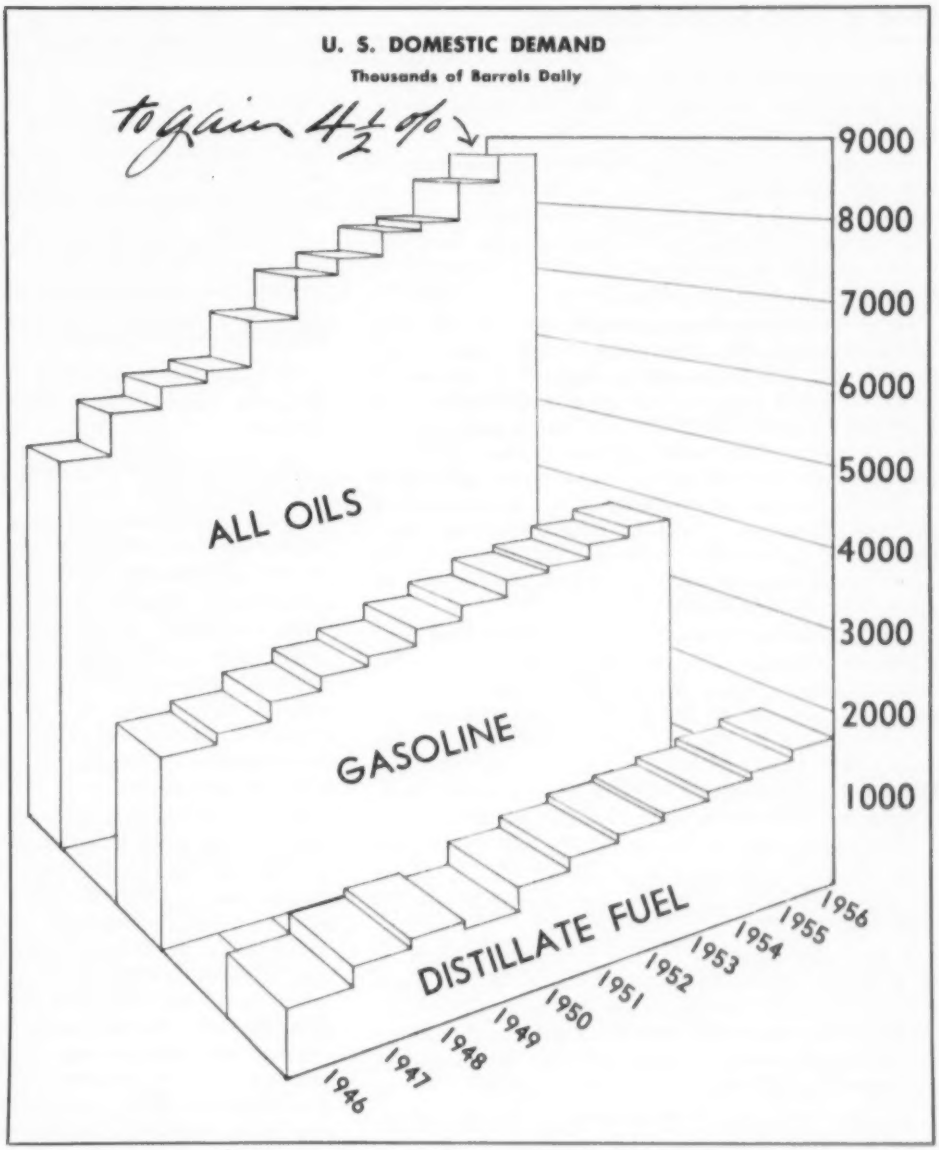
**Estimated U. S. Domestic Demand—1956**
(Thousands of Barrels Daily)

| | 1954 | 1955 | Percent Change | 1956 | Percent Change |
|---|---|---|---|---|---|
| **All Oils** | **7,752** | **8,375** | **+ 8.0** | **8,750** | **+ 4.5** |
| Gasoline | 3,393 | 3,610 | + 6.4 | 3,745 | + 3.7 |
| Kerosine | 324 | 318 | — 1.9 | 320 | + 0.6 |
| Distillate Fuel | 1,442 | 1,575 | + 9.2 | 1,680 | + 6.7 |
| Residual Fuel | 1,430 | 1,510 | + 5.6 | 1,520 | + 0.7 |
| Other Products | 1,163 | 1,362 | +17.1 | 1,485 | + 9.0 |

oil use, consuming more than 60 percent of the free world total, but the other free areas are rapidly making greater use of this great source of energy.

**Oil consumption** in the free world averaged an estimated 13,675,000 barrels daily during 1955, which was an increase of 9.2 percent over the 12,527,000 barrels used in 1954. However, demand in free areas outside U. S. increased 11 percent over 1954. Those areas accounted for 38.1 percent of the free world total in 1954, but had upped that proportion to 38.6 percent in 1955.

Free world demand is expected to reach 14,500,000 barrels daily in 1956, for a 6 percent gain over the 1955 rate, but again the areas outside the U. S. will enjoy the greater rate of increase. These nations are expected to consume an average of 5,750,000 barrels of oil daily during 1956, which would represent a hike of 8.5 percent over 1955 and 39.7 percent of all oil consumed by the free world.




The pace-setter in the growing foreign oil market is Western Europe, where expanding industrialization is expected to maintain this growing need for petroleum. Western European oil consumption amounted to about 2,500,000 barrels daily during 1955, and that was an increase of about 10 percent over the approximately 2,250,000 barrels needed in 1954. Requirements for 1956 should be 8 to 9 percent higher than last year's. Since the war, European oil consumption has increased more than 180 percent, and is now almost three times the immediate postwar level. Nevertheless, it has been estimated that it will require another 20 years for European oil demand to equal the U. S. rate of 10 years ago.

Even greater possibilities exist in Latin America. Expanding Latin American economy is being based more on petroleum than in any other area. Population now is only a little less than in the U. S., and the gap is being closed pretty rapidly. At the same time, per capita consumption is rising sharply. These factors indicate that Latin American countries will be using something like 3¼ million barrels of oil daily by 1975, over twice their present volume of 1¼ million barrels per day.

A great variance in per capita oil consumption exists throughout the world. Far in the lead is the U. S., where oil is used at the average rate of almost 20 barrels per person annually. In the remainder of North America, per person consumption amounts to about 4½ barrels a year. At the other end of the scale is Asia with a per capita oil use of less than ⅓ barrel annually. The universal average is slightly more than 2 barrels.

**To meet the stepped-up** U. S. demand in 1955, the nation's refineries ran a total of 2,730,200,000 barrels of crude, for a daily average of 7,480,000 barrels. Those daily runs were a new high for the industry and were 7.5 percent higher than the 6,958,000 barrels refined daily during 1954. However, runs during 1954 had been

depressed somewhat from the previous peak of 7,000,000 daily during 1953. Refinery runs are expected to average 7,800,000 or more barrels daily in 1956.

In order for the refining industry to maintain its 7,480,000-barrel-a-day charging rate in 1955, it had to operate its plants at 87.6 percent of their rated capacities. The depressed activity of 1954 had occupied only 82.6 percent of capacity. In prewar years, 65 to 75 percent of the national capacity had been utilized.

Domestic consumption of gasoline last year averaged 3,610,000 barrels daily, which represented a gain of 6.4 percent over 1954's use, and is expected to amount to 3,745,000 barrels a day in 1956. That would figure to be a gain of 3.7 percent over last year, which may prove to be conservative. This smaller gain in gasoline consumption forecasted for 1956 is partly based on the automotive industry's expectance of producing fewer new automobiles this year. However, it will be remembered that early forecasts of automobile production for 1955 were far too low, and that the result was a new all-time peak of approximately eight million vehicles.

Both distillate and residual fuel oils enjoyed substantial climbs in usuage last year, but the outlook for this year indicates some leveling out of the increase curve for these fuels, particularly the residuals. Distillate fuel oils were consumed at the rate of 1,575,000 barrels daily during 1955, for a gain of 9.2 percent over the 1954 rate. However, an increase of 6.7 percent is expected this year, bringing the daily rate to approximately 1,680,000 barrels.

The residuals were used at the rate of 1,510,000 barrels daily last year, an increase of 5.6 percent over 1954, and are expected to level out this year at very nearly the same rate as in 1955.

A long range outlook for the petroleum industry by N. B. Guyol, United Nations staff statistician, presented at the 1955 annual meeting of the API in San Francisco, predicted that along with some slowing down of the over-all rate of growth there would be different rates of increase in demand for different products of the industry.

The very high rates of development of the oil and gas markets during recent years have been made possible, Guyol explained, by the expansion of the U. S. economy and the displacement of other sources of energy from their actual or potential markets. In the coming decade, he continued, the rates of development in oil and gas sales may be expected to decline until they reach about the same level as rates of growth in useful requirements of all energy. This rate is 4 to 5 percent per year, he added.

In the case of clean oils—including everything from gasolines through distillate fuel oils—an early decline from the recent high expansion rate is in prospect, Guyol predicted. There is some possibility that these oils will be displaced to some extent by natural gas, he added.

"I would expect the market for these oils, which has been developing at the rate of 7 percent per annum, to develop at a rate of no more than 5 percent per annum after 1960," said Guyol, "with the rate beginning to fall within the next three years."

He added that he expects a shift away from the lighter distillates, especially the gasolines, and toward the middle distillates.

**The future market** for residual fuel oil is unpredictable, according to Guyol. Portions of this market—such as the railways—have already been lost to other fuel oils, and further losses are in prospect, especially in the transport sector of the economy, he stated.

Two large potential markets exist for residual fuel oil. These are electric power plants and industrial establishments. They could absorb much more residual than the U. S. is likely to produce, Guyol stated. How much residual fuel oil they actually will use, however, will depend, he said almost entirely on the price of residual in comparison with prices of competitive fuels, especially coal and natural gas.

At the same meeting, John J. Winger, petroleum economist, The Chase National Bank, New York, agreed that in 1956 business volume would increase further but less sharply than in 1955. He said that petroleum consumption has become increasingly sensitive to general business trends and is stimulated or retarded accordingly. Winger said, "We see nothing in the business picture next year which would materially alter the normal growth trend of petroleum use." Greater consideration of general business trends is now taken in forecasting demand for petroleum products, Winger revealed. Petroleum use is becoming increasingly sensitive to over-all economic conditions, because oil is supplying a steadily growing proportion of the nation's energy requirements, he stated.

Concerning the long range outlook of the U. S. petroleum industry, Winger was optimistic. "Our studies thus far," he disclosed, "have indicated oil demand in 1965 ranging from 13 million to 14½ million barrels per day."

Heavy capital outlays by the processing industry will continue this year, as the refining, natural gasoline, and petrochemical segments construct and modernize to meet growing demands with better products. The refining branch is expected to expend about $430 million on new construction and something like $400 million on modernization, which should result in an additional 250,000 barrels-per-day refining capacity.

New natural gasoline construction will represent an outlay of approximately $110 million, and petrochemical plant building will call for an expenditure of about $420 million.

**U. S. Refinery Capacity and Crude Oil Run to Stills**
(Barrels Per Day)

| YEAR | Refinery Capacity | Crude Runs to Stills | Percent Capacity Operated |
|---|---|---|---|
| 1955 | 8,534,900 | 7,480,000 | 87.6 |
| 1954 | 8,420,630 | 6,957,700 | 82.6 |
| 1953 | 8,006,897 | 6,999,600 | 87.4 |
| 1952 | 7,638,661 | 6,670,100 | 87.3 |
| 1951 | 7,332,885 | 6,494,300 | 88.6 |
| 1950 | 6,963,644 | 5,739,400 | 82.4 |
| 1949 | 6,696,300 | 5,326,600 | 79.5 |
| 1948 | 6,438,995 | 5,596,600 | 86.9 |
| 1947 | 6,034,252 | 5,074,600 | 84.1 |
| 1946 | 5,569,482 | 4,740,300 | 85.1 |
| 1945 | 5,315,856 | 4,711,100 | 88.6 |
| 1940 | 4,718,969 | 3,545,600 | 75.1 |
| 1935 | 4,117,047 | 2,646,000 | 64.3 |
| 1930 | 3,942,685 | 2,540,900 | 64.4 |
| 1925 | 2,852,967 | 2,027,200 | 71.1 |

**Source:** American Petroleum Institute.

[1] Excerpt from a recently released analysis of the oil industry by Standard & Poor's Corporation.

# Heat Exchanger Design

Part 1: Types and Arrangements
Part 2: Heat Transfer
Part 3: Fluid Flow and Thermal Design
**Part 4: Mechanical Design**

**AFTER YOU'VE mastered the fundamentals described in the first three parts of this series, you're ready for the features of mechanical design described here. Mechanical design divides conveniently into tubes; tube sheets; baffles; tie rods, spacers and nuts; floating-head cover; shell; channel and channel cover; and flange design.**

**Daniel A. Donohue,** Chemical Construction Corporation, New York

CODES HAVE BEEN developed over the years which deal with the mechanical design and fabrication of pressure vessels. The primary consideration of the Code is safety. In petroleum refinery practice the basic code for unfired pressure vessels, under which classification heat exchangers fall, is the API-ASME Code[7] which is patterned after the ASME Code for Unfired Pressure Vessels.[8] Supplementing this the Tubular Exchanger Manufacturers Association, Inc., has published a booklet of "Standards"[9] dealing exclusively with heat exchangers which covers construction details and manufacturing tolerances. Besides these codes which have been formulated for general use, many of the larger oil companies have developed construction specifications of their own, some of which are quite detailed.

The size designation of the unit which has been selected is a #20-192. It is customary to set the design pressure of units of this size in increments of 150 psi which means that the unit shall be designed for 300 psi on the shell side and 150 psi on the tube side. Following are the design conditions.

| | Shell | Tube |
|---|---|---|
| Design Pressure, psi | 300 | 150 |
| Test Pressure, psi | 450 | 225 |
| Design Temperature, F. | 300 | 150 |

A corrosion allowance of ⅛ inch is to be added to both shell and tube sides for all steel parts except tubes. In the course of the design calculations which follow reference is made to the API-ASME Code, 1951 edition,[7] the ASME Code, 1952 edition[8] and the TEMA Standards, 1952 edition, with October, 1954, Addenda.[9]

**Tubes**—Material: Admiralty, B-111. For water-cooled units in refinery service ¾-inch OD admiralty tubes are generally used. For this tube material, a thickness of 16 BWG (0.065 inch) is recommended on page 8 of TEMA Standards and 16 feet is listed as the maximum standard length.

This size tube is checked with reference to the ASME Code[8] for internal and external pressure as follows.

*A—Internal Pressure*—Paragraphs UG-31 (a) and UG-27, ASME Code:[8]

$$t = \frac{PR}{SE - 0.6P}$$

$$t = \frac{150\ (0.31)}{10{,}000\ (1) - 0.6\ (150)} = 0.00469 \text{ inch} \qquad (42)$$

where E = joint efficiency, for seamless shells E = 1
P = design pressure, psi
R = inside radius, inches
S = maximum allowable stress, psi
t = minimum required thickness, exclusive of corrosion allowance, inches

*B—External Pressure*—Paragraph UG-31 (b), ASME Code:[8] Figure UG-31 is used to determine the external pressure which the tube is suitable for. $t/D_o = 0.065/0.75 = 0.0866$ and from Table UNF-23 the design stress for admiralty tubing at 150 F. is 10,000 psi. When the values are located on Figure UG-31 the corresponding external design pressure is found to be 830 psi.

The ⅛-inch extra thickness to allow for corrosion on both shell and on tube sides which is added to all other parts of the exchanger is not added to the tubes.

**Tube Sheets**—Material: Naval Brass, SB-171.

*A—Stationary Tube Sheet*—The required thickness of the stationary tube sheet in bending is calculated from the formula on page 13 of the TEMA Standards.

$$t = FG\sqrt{\frac{0.25\ P}{S}} \qquad (43)$$

where F = Factor for tube sheet support and loading
G = mean gasket diameter for stationary tube sheet, inches
P = design pressure on shell or tube side, whichever is greater, psi
S = allowable working stress at design temperature, psi
t = Thickness of tube sheet measured at bottom of partition groove, inches

$$t = 21\tfrac{3}{8}\sqrt{\frac{0.25\ (300)}{12{,}500}} = 1.68 = 1\tfrac{11}{16} \text{ inches}$$

The condition of the stationary tube sheet is checked by use of Paragraph R-7.122 of the TEMA addenda.[9]

$$t = \frac{0.31\ D_L}{\left(1 - \frac{d}{p}\right)}\left(\frac{P}{S}\right) \qquad (74)$$

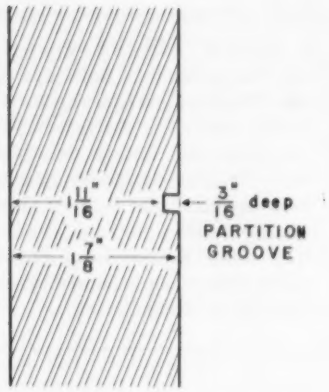



FIGURE 32—Cross section of tube sheet.

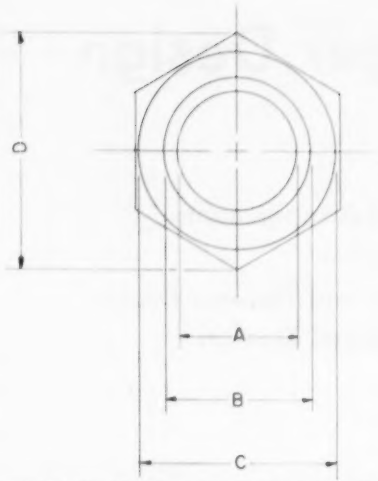



FIGURE 33—Tie rod, spacer, and nut. A = tie rod, ½" O.D. B = spacer, ½" STD. WT. pipe (Sch. 40) I.D. 0.622". C = spacer ½" STD. WT. pipe (Sch. 40) O.D. 0.84. D = hexagonal nut, 1.01" across edges.

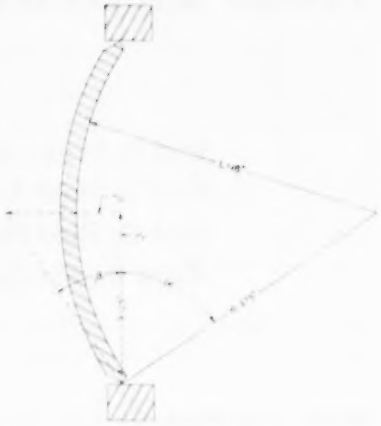


FIGURE 34

where d = outside tube diameter, inches
$D_L$ = diameter of limiting circle circumscribing tube centers = O.T.L. — d, inches
p = tube pitch, inches

$$t = \frac{0.31\,(17.25)}{\left(1 - \frac{0.75}{0.9375}\right)}\left(\frac{300}{12{,}500}\right) = 0.642 \text{ inch}$$

A cross-sectional view of the tube sheet is shown in Figure 32. To the thickness of $1\frac{11}{16}$ inches, which has been calculated as necessary to withstand the more severe stress of bending an additional thickness of $\frac{3}{16}$ inch is added to the channel side to permit cutting a pass partition groove of that depth.

The tube sheet is $1\frac{7}{8}$ inches thick ($1\frac{11}{16}$ inches at the groove) and its outside diameter is 22 inches.

*B—Floating Tube Sheet*—Although the outside diameter of the floating tube sheet is 19 inches, the same thickness is used for it as for the stationary tube sheet, $1\frac{7}{8}$ inches.

**Baffles**—Material: Commercial quality steel; diameter: 19.1 inches; thickness: $\frac{3}{16}$ inch; baffle hole diameter: $\frac{25}{32}$ inch.

**Tie Rods, Spacers and Nuts**—Material: Commercial quality steel. The baffles are held in place by means of tie rods. These are solid steel rods of ½-inch OD having threaded ends one of which screws into the stationary tube sheet. Spacers, which consist of ½-inch standard weight steel pipe (schedule 40, ID = 0.622 inch OD = 0.84 inch), slip over the tie rods and fit between the baffles. The other end of the tie rod is capped with a ½-inch hexagonal nut which is ⅞-inch across the flats and 1.01-inch across the edges. A wrench to remove the nuts would require 1½ inches clearance. Dimensions are shown in Figure 33.

**Floating-Head Cover**—The floating-head cover is shown in Figure 34 and is of the spherically dished type shown in Figure W-316.2 (d) of the API-ASME Code.[7]

*I—Dished Head*—Material: ASTM A-285, Gr. C. The thickness of the dished head is calculated by use of equation (6) in Paragraph W-316 (b) (2) (d).

$$t = \frac{5\,pL}{6\,sE} = \frac{5\,(300)\,(16)}{6\,(13{,}750)} = 0.291 \text{ inch} \qquad (44)$$

where E = efficiency of the joint in the head
L = inside spherical or crown radius, inches
p = design pressure, psi
s = maximum allowable stress from Table W-306.1, psi
t = minimum required thickness of head plate after forming, exclusive of corrosion allowance, inches

Since this head has the greater pressure on the outside its thickness must be increased 67 percent under Paragraph W-316 (b) (3) and Paragraph EW-311 (a) (1).

$$t = 0.291/0.6 = 0.485 \text{ inch} \qquad (45)$$

To this is added ⅛ inch corrosion allowance on each side which increases the required thickness to 0.735 inch. A ¾ inch minimum thick dished head with an inside radius of 16 inches is used.

*II—Flange*—A cross-sectional view of the floating-head-cover flange is shown in Figure 35. Materials: Flange—ASTM A-285, Gr. C.; bolts—alloy steel ASTM A-193, Gr. B-7; gasket—copper clad asbestos.

*A—Bolt Loads*—W-317 (f) (1) API-ASME Code.

a—Operating Bolt Load

$$W_{m1} = H + H_p \qquad (46)$$

$$= \frac{\pi}{4} G^2P + 2b\,\pi\,GmP \qquad (46a)$$

$$= \frac{\pi}{4}(18.625)^2\,150 + 2(0.1875)\,(3.14)\,(18.625)\,(3.5)\,(150)$$

$$= 52{,}500 \text{ pounds}$$

b—Bolt Load Required to Seat Gasket

$$W_{m2} = H_y = \pi\,bGy \qquad (47)$$

$$= \pi\,(0.1875)\,(18.625)\,(6500) = 71{,}500 \text{ pounds}$$

c—Bolting

The required bolt area, $A_m$, must equal the greater of the bolt areas calculated as follows: The bolt area required at operating conditions with internal pressure is

$$A_{m1} = \frac{W_{m1}}{S_b} \qquad (48)$$

$$A_{m1} = \frac{52{,}500 \text{ lb.}}{20{,}000 \text{ lb./sq. in.}} = 2.625 \text{ sq. in.}$$

The bolt area required at atmospheric temperature without internal pressure is

$$A_{m2} = \frac{W_{m2}}{S_a} \qquad (49)$$

$$A_{m2} = \frac{71{,}500 \text{ lb.}}{20{,}000 \text{ lb./sq. in.}} = 3.575 \text{ sq. in.}$$

and $A_m = 3.575$ sq. in.

28⅝-inch bolts are used for which the actual bolt area is

$$A_b = 0.202 \frac{\text{sq. in.}}{\text{bolt}} \times 28 \text{ bolts} = 5.65 \text{ sq. in. root area}$$

d—Flange Design Bolt Load

$$W = \frac{(A_m + A_b)\, S_a}{2} \qquad (50)$$

$$W = \frac{(3.575 \text{ sq. in.} + 5.65 \text{ sq. in.})\ 20{,}000 \text{ lb./sq. in.}}{2} = 92{,}250 \text{ lb.}$$

where

$A_b$ = actual cross-sectional area of bolts, sq. in.
$A_m$ = required cross-sectional area of bolts, sq. in.
$A_{m1}$ = bolt area required at operation conditions with internal pressure, sq. in.
$A_{m2}$ = bolt area required at atmospheric temperature without internal pressure, sq. in.
b = effective gasket seating width, inches
G = mean gasket diameter, inches
H = total hydrostatic end force, pounds
$H_p$ = total joint-contact surface compression load, pounds
$H_y$ = total joint-contact-surface seating load, pounds
m = unit contact compression factor from Table W-317.1, API-ASME Code
P = design pressure, psi
$S_a$ = allowable bolt stress at atmospheric temperature from Table W-306.1, API-ASME Code, psi
$S_b$ = allowable bolt stress at operating temperature from Table W-306.1, API-ASME Code, psi
$W = \frac{(A_m + A_b)\, S_a}{2}$, pounds
$W_{m1} = H + H_p$, pounds
$W_{m2} = H_y$, pounds
y = gasket seating load from Table W-317.1, API-ASME Code, psi

*B—Flange Moment*—The flange may be calculated as a loose-type following paragraph W-317 (h) (1) of the API-ASME Code.

a—Flange Loads

$$H_D = \frac{\pi}{4} B^2 P = \frac{\pi}{4} (18.25)^2\, 150 = 39{,}200 \text{ lb.} \qquad (51)$$

$$H_G = W - H = 92{,}250 - 41{,}000 = 51{,}250 \text{ lb.} \qquad (52)$$

$$H_T = H - H_D = 41{,}000 - 39{,}200 = 1{,}800 \text{ lb.} \qquad (53)$$

b—Lever Arms

$$h_D = \frac{C - B}{2} = \frac{20\frac{1}{2} - 18\frac{1}{4}}{2} = 1.125 \text{ inches} \qquad (54)$$

$$h_G = \frac{C - G}{2} = \frac{20\frac{1}{2} - 18\frac{5}{8}}{2} = 0.9375 \text{ inch} \qquad (55)$$

$$h_T = \frac{h_D + h_G}{2} = \frac{1.125 + 0.9375}{2} = 1.031 \text{ inches} \qquad (56)$$

c—Moments

$$M_D = H_D\, h_D = 39{,}200\ (1.125) = 42{,}100 \text{ lb.-in.} \qquad (57)$$

$$M_G = H_G\, h_G = 51{,}250\ (0.9375) = 48{,}100 \text{ lb.-in.} \qquad (58)$$

$$M_T = H_T\, h_T = 1{,}800\ (1.031) = 1{,}860 \text{ lb.-in.} \qquad (59)$$

$$M_o = M_D + M_G + M_T = 92{,}060 \text{ lb.-in.} \qquad (60)$$

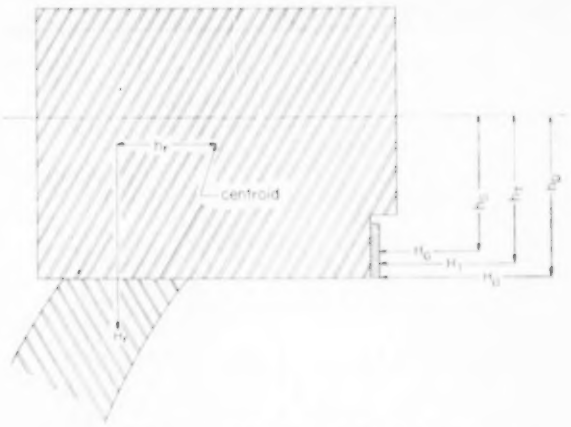



**FIGURE 34A—Moments in flange of floating-head cover.**

In addition to the moments already calculated there is an additional moment for this type of head as shown in Figure W-316.2 (d), API-ASME Code which is calculated as follows. From Figure 34

$$\cos \alpha = \frac{9.125}{16.375} = 0.557 \quad \alpha = 56° \quad \beta_1 = 90 - \alpha = 34°$$

$$H_r = H_D \cot \beta_1 = 39{,}200\ (1.4826) = 58{,}200 \text{ lb.} \qquad (61)$$

When the center of the dished head is located beyond the centroid of the cross section of the ring flange (shown to the left of the centroid in Figure 34A) then the moment $M_r$ opposes $M_D + M_G + M_T$. For convenience it is omitted from this calculation.

Where

B = inside diameter of flange, inches
C = bolt circle diameter, inches
G = mean gasket diameter, inches
$h_D$ = lever arm of force $H_D$ about bolt center, inches
$h_G$ = lever arm of force $H_G$ about bolt center, inches
$h_r$ = lever arm of force $H_r$ about centroid of flange ring, inches
$h_T$ = lever arm of force $H_T$ about bolt center, inches
H = total hydrostatic end force, pounds
$H_D$ = hydrostatic pressure end load, pounds
$H_G$ = W — H, pounds
$H_r$ = radial component of the membrane load in the spherical segment, pounds
$H_T$ = H — $H_D$, pounds
$M_D$ = $H_D\, h_D$, lb.-in.
$M_G$ = $H_G\, h_G$, lb.-in.
$M_o$ = total moment acting upon flange, lb.-in.
$M_T$ = $H_T\, h_T$, lb.-in.
P = design pressure, psi
W = flange design bolt load, pounds
$\alpha$ = angle shown in Figure 34, degrees
$\beta_1$ = angle shown in Figure 34, degrees

*C—Flange Thickness*—The required thickness of the flange is calculated by use of equation (7), paragraph W-316 (b) (2) (d) of the API-ASME Code.

$$F = \frac{pB}{8s} \frac{\sqrt{4L^2 - B^2}}{(A - B)} = \frac{150\ (18.25)}{8\ (13{,}750)} \frac{\sqrt{1024 - 332}}{(22 - 18.25)} = 0.174 \qquad (62)$$

$$J = \frac{M_o}{sB} \frac{(A + B)}{(A - B)} = \frac{92{,}060}{13{,}750\ (18.25)} \frac{22 + 18.25}{22 - 18.25} = 3.94 \qquad (63)$$

$$T = F\left[1 + \sqrt{1 + \frac{J}{F^2}}\right] = 0.296\left[1 + \sqrt{1 + \frac{3.94}{0.0304}}\right] = 2.17 \text{ inches} \qquad (64)$$

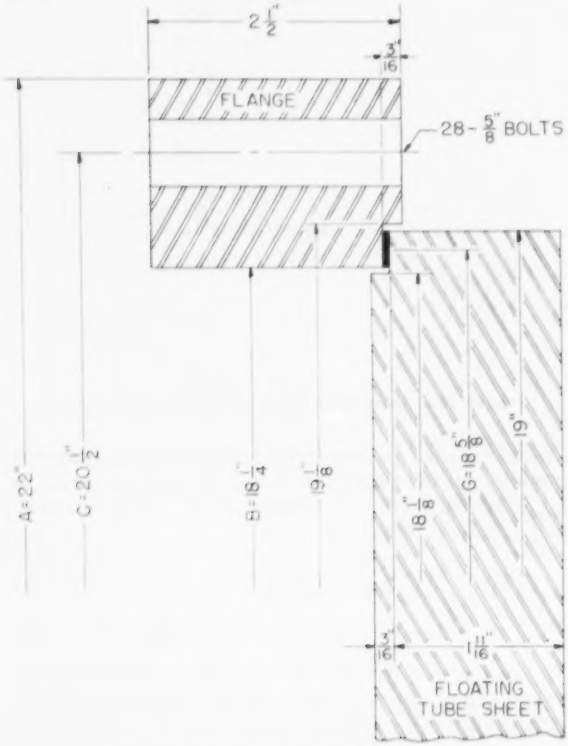



FIGURE 35—Floating-head-cover flange.

A corrosion allowance of ⅛-inch is added to each side and the thickness becomes 2½ inches.

where A = outside diameter of flange, inches
B = inside diameter of flange, inches
L = inside spherical or crown radius, inches
$M_o$ = total moment acting upon flange, lb.-in.
p = design pressure, psi
s = maximum allowable stress of flange material, psi
T = flange thickness without corrosion allowance, inches

**Shell**—Material: Seamless steel pipe ASTM A-106, Grade B. The required minimum thickness of the shell is calculated from Paragraph W-309 of the API-ASME Code.

$$t = \frac{pR_o}{sE + 0.4p} + c \qquad (65)$$

where c = corrosion allowance, inches
E = efficiency of longitudinal joint (for seamless shells = 1)
p = design pressure, psi
$R_o$ = outside radius, inches
s = maximum allowable working stress from Table W-306.1, psi
t = minimum required thickness (exclusive of corrosion allowance), inches

$$t = \frac{300\ (10)}{15{,}000 + (0.4)\ (300)} + \frac{1}{8} = 0.323 \text{ inch}$$

A standard weight seamless steel pipe of 20-inch OD and nominal ⅜-inch thick wall (Schedule 20) is used for the shell. Its allowable minimum thickness is 87.5 percent of the nominal or 0.328 inch.

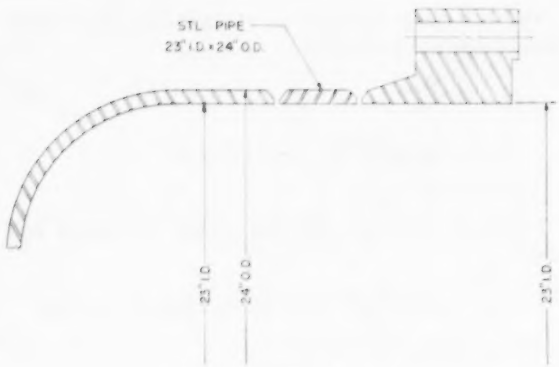



FIGURE 36—Shell cover.

**Shell Cover**—The shell cover, shown in Figure 36, consists of dished head, barrel and flange. These three parts are welded together.

*A—Dished Head*—Material: Carbon steel, A-285, Grade C. The required thickness of a dished head of semi-ellipsoidal form is calculated from Paragraph W-311 (c) of the API-ASME Code.

$$t = \frac{pDV}{2sE - 0.2p} + c \qquad (66)$$

where D = inside diameter of major axis, inches
V = 1 for a semi-ellipsoidal form (D/2h = 2)

$$t = \frac{300\ (23.25)}{2\ (13{,}750) - (0.2)\ (300)} + \frac{1}{8} = 0.379 \text{ inch}$$

A plate of 7/16 inch minimum thickness after forming is required which calls for a plate ½ inch thick before forming.

*B—Barrel*—Material: Seamless steel pipe, ASTM A-106, Grade B. The required thickness is figured in exactly the same manner as for the shell by use of equation (65).

$$t = \frac{300\ (12)}{15{,}000 + (0.4)\ (300)} + \frac{1}{8} = 0.363 \text{ inch}$$

A ½ inch thick pipe of 24-inch OD is used for the barrel.

*C—Flange*—Material: Forged steel, ASTM A-105, Grade I. A TEMA 300 psi Standard Hub flange is used. Its dimensions are listed in the tabulation for "Shell Flange At Cover End," of the TEMA Standards,[9] page 21, line 7, for a 20-inch OD size.

**Channel**—Material: Seamless steel pipe ASTM A-106, Grade B. The required thickness of channel is calculated from the same formula used for shell and shell-cover barrel, equation (65).

$$t = \frac{150\ (10)}{15{,}000 + (0.4)\ (150)} + \frac{1}{8} = 0.2247 \text{ inch}$$

A standard weight, seamless steel pipe of 19¼-inch OD and 20-inch OD is used for the channel.

**Channel Cover**—Material: Cover—Steel plate, ASTM A-285, Grade C; bolts—alloy steel, ASTM A-193, Grade B-7; gasket—asbestos, 1/16 inch thick, ⅜ inch wide.

As a preliminary to the calculation of the channel cover thickness it is necessary to evaluate the bolt loads following Paragraph W-317 (f) of the API-ASME Code.

*A—Bolt Loads*

a—Required Operating Bolt Load

$$W_{m1} = H + H_p \quad (46)$$

$$= \frac{\pi}{4} G^2P + 2b\,\pi\,GmP \quad (46a)$$

$$= \frac{\pi}{4} (21\tfrac{3}{8})^2\,150 + 2(0.1875)\,(\pi)\,(21\tfrac{3}{8})\,(2.75)\,(150)$$

$$= 55{,}000 + 10{,}550 = 65{,}550 \text{ pounds.}$$

b—Bolt Load Required to Seat Gasket

$$W_{m2} = H_y = \pi\,bGy \quad (47)$$

$$= \pi\,(0.1875)\,(21\tfrac{3}{8})\,(3700) = 47{,}000 \text{ pounds}$$

c—Bolting

The required bolt area is the greater of the two following values.

$$A_m = \frac{W_{m1}}{s_b} = \frac{65{,}500 \text{ lb.}}{20{,}000 \text{ lb./sq. in.}} = 3.275 \text{ sq. in.} \quad (48)$$

$$A_m = \frac{W_{m2}}{s_a} = \frac{47{,}000 \text{ lb.}}{20{,}000 \text{ lb./sq. in.}} = 2.35 \text{ sq. in.} \quad (49)$$

Twenty-four ¾-inch bolts are used.

$$A_b = 24 \times 0.302 \text{ sq. in.} = 7.25 \text{ sq. in.}$$

d—Flange Design Bolt Load

$$W = \frac{(A_m + A_b)\,s_a}{2} = \frac{(3.75 + 7.25)\,20{,}000}{2} = 105{,}250 \text{ pounds} \quad (50)$$

*B—Thickness*

The thickness of the channel cover is calculated from Paragraph W-316 of the API-ASME Code.

$$t = d\sqrt{\frac{Cp}{s}} + c \quad (67)$$

The type of cover is that illustrated in Figure W-316.1 (g) for which

$$C = 0.30 + \frac{1.4\,Wh_G}{Hd} \quad (68)$$

where d = mean gasket diameter, inches
$h_G$ = (bolt circle diameter − d)/2, inches
p = design pressure, psi
s = allowable stress of cover material from Table W-306.1, psi
t = required cover thickness, inches
W = bolt load used to design flange, pounds

$$C = 0.3 + \frac{1.4\,(105{,}250)\,(0.8125)}{55{,}000\,(21.625)} = 0.401$$

$$t = 21\tfrac{3}{8}\sqrt{\frac{0.401\,(150)}{13{,}750}} + \frac{1}{8} = 1.56 \text{ inches}$$

The nearest thickness 1¾ inches will be used.

The TEMA Standards Paragraph R-8.21 contains rules for calculating the required thickness of the channel cover which take into account channel partitions and the deflection of the cover at its center. The application of these rules to this particular case results in exactly the same thickness of channel cover as was calculated by use of the API-ASME Code above.

**Flange Design**—The external flanges which are shown in Figures 6 and 7 are designated by the numbers 1 to 5 inclusive. They are all of the hubbed integral type shown in Figure W-317.1 (6) of the API-ASME Code. In order to illustrate the method used to design these flanges, the thickness of the shell flange which is bolted to the stationary tube sheet and designated as flange No. 3 in Figure 7 will be calculated. A cross-sectional view of this flange is shown in Figure 37. The channel flange on the other side of the stationary tube sheet which is designated as flange No. 2 in Figure 7 is made a duplicate of flange No. 3 because it bolts to it.

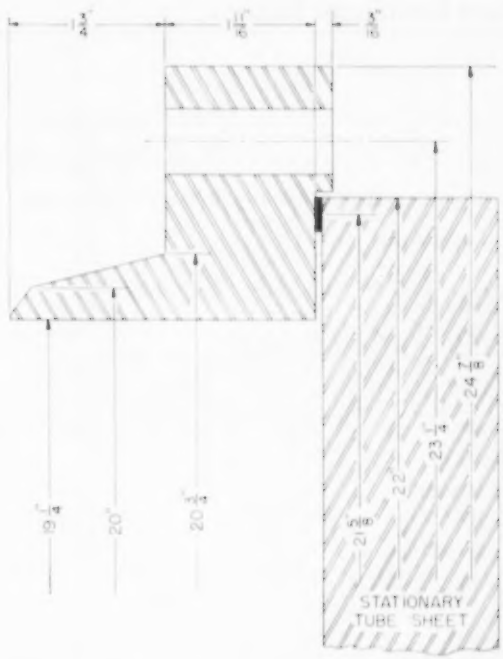



**FIGURE 37—300-pound hub flange at stationary tube sheet.**

*A—Bolt Loads*—The flange design bolt load is computed by the same method previously used for the floating head cover flange and the channel-cover flange as described in Paragraph W-317 (f) of the API-ASME Code. Material: Flange—ASTM A-105, Grade 1; bolts—alloy steel, ASTM A-193, Gr. B-7; gasket—stainless steel clad asbestos.

a—Operating Bolt Load

$$W_{m1} = H + H_p \quad (46)$$

$$= \frac{\pi}{4} G^2P + 2b\,\pi\,GmP \quad (46a)$$

$$= \frac{\pi}{4} (21.625)^2\,300 + 2\,(0.1875)\,(\pi)\,(21.625)\,(3.75)\,(300) =$$

$$139{,}100 \text{ pounds}$$

b—Bolt Load Required to Seat Gasket

$$W_{m2} = H_y = \pi\,bGy \quad (47)$$

$$= \pi\,(0.1875)\,(21.625)\,(9000) = 115{,}000 \text{ pounds}$$

c—Bolting. The bolting must be able to withstand either the operating bolt load or the bolt load required to seat the gasket, whichever is greater.

$$A_m = \frac{W_{m1}}{s_b} = \frac{139{,}100}{20{,}000} = 6.955 \text{ sq. in.} \quad (48)$$

$$A_m = \frac{W_{m2}}{s_a} = \frac{115{,}000}{20{,}000} = 5.75 \text{ sq. in.} \quad (49)$$

The actual bolt area must be at least 6.955 square inches. The 300 psi standard TEMA Class R flange has twenty-four ¾-inch bolts.

$$A_b = 0.302 \text{ sq. in. } (24) = 7.25 \text{ sq. in.}$$

d—Flange Design Bolt Load

$$W = \frac{(A_m + A_b)\,s_a}{2} = \frac{(6.955 + 7.25)\,20{,}000}{2} = 142{,}050 \text{ pounds} \quad (50)$$

*B—Flange Moment*—To calculate the moments acting upon the flange, Paragraph W-317 (h) (2) of the API-ASME Code is followed.

a—Flange Loads

$$H_D = \frac{\pi}{4} B^2 P = \frac{\pi}{4} (19.5)^2 300 = 89{,}500 \text{ pounds} \quad (51)$$

$$H_G = W - H = 142{,}050 - 110{,}000 = 32{,}050 \text{ pounds} \quad (52)$$

$$H_T = H - H_D = 110{,}000 - 89{,}500 = 20{,}500 \text{ pounds} \quad (53)$$

b—Lever Arms

$$h_D = R + \frac{g_1}{2} = 1.25 + \frac{0.62}{2} = 1.56 \text{ inches} \quad (69)$$

$$h_G = \frac{C - G}{2} = \frac{23.25 - 21.625}{2} = 0.8125 \text{ inch} \quad (55)$$

$$h_T = \frac{R + g_1 + h_G}{2} = \frac{1.25 + 0.62 + 0.8125}{2} = 1.34125 \text{ inches} \quad (70)$$

c—Moments

$$M_D = H_D h_D = 89{,}500\ (1.56) = 139{,}600 \text{ lb.-in.} \quad (57)$$
$$M_G = H_G h_G = 32{,}050\ (0.8125) = 26{,}000 \text{ lb.-in.} \quad (58)$$
$$M_T = H_T h_T = 20{,}500\ (1.34125) = 27{,}600 \text{ lb.-in.} \quad (59)$$
$$M_o = M_D + M_G + M_T = 193{,}200 \text{ lb.-in.} \quad (60)$$

*C—Flange Stresses*—Stresses in hubbed flanges are calculated by use of the following formulas taken from Paragraph W-317 (j) (1) of the API-ASME Code:

Longitudinal Hub Stress $$S_H = \frac{fM_o}{Lg_1^2B} \quad (71)$$

Radial Flange Stress $$S_R = \frac{(4/3\ te + 1)\ M_o}{Lt^2B} \quad (72)$$

Tangential Flange Stress $$S_T = \frac{YM_o}{t^2B} - ZS_R \quad (73)$$

The factors used in these equations depend on the shape of the flange and may be obtained from charts in Paragraph W-317 of the API-ASME Code.[1] Referring to Figure W-317.3, since $K = A/B = 24.875/19.5 = 1.276$, then $U = 8.91$, $Y = 8.11$, $Z = 4.18$ and $T = 1.81$.

In order to obtain f, F and V the following terms are evaluated:

$$g_1/g_o = 0.62/0.244 = 2.54$$
$$h = 1.75$$
$$h_o = \sqrt{Bg_o} = \sqrt{19.5\ (0.244)} = 2.18$$
$$h/h_o = 1.75/2.18 = 0.803$$

From Figure W-317.4 $F = 0.743$ and $V = 0.12$, and from Figure W-317.2 $f = 1$.

$$d = \frac{U}{V} h_o g_o^2 = \frac{8.91}{0.12}(2.18)\ (0.244)^2 = 9.6$$

$$e = F/h_o = 0.748/2.18 = 0.34$$

$$L = \frac{te + 1}{T} + \frac{t^2}{d} = \frac{(1.6875)\ (0.34) + 1}{1.81} + \frac{4.8}{9.6} = 1.37$$

These values are substituted in equations (71), (72) and (73) and the stresses calculated as follows.

$$S_H = \frac{fM_o}{Lg_1^2B} = \frac{1\ (193{,}200)}{1.37\ (0.385)\ (19.5)} = 18{,}800 \text{ psi} \quad (71)$$

This is below the allowable value of 1.5 $s_f$ which equals 22,500 psi.

$$S_R = \frac{(4/3te + 1)\ M_o}{Lt^2B} = \frac{[(4/3\ (1.6875)\ (0.34) + 1]\ 193{,}200}{1.37\ (2.44)\ (19.5)} = 5230 \text{ psi} \quad (72)$$

The allowable stress $S_f$ is 15,000 psi.

$$S_T = \frac{YM_o}{t^2B} - ZS_R = \frac{8.11\ (193{,}200)}{2.85\ (19.5)} - 4.18\ (5230) = 6350 \text{ psi} \quad (73)$$

This is less than the allowable stress 15,000 psi.

$$\frac{S_H + S_R}{2} = \frac{18{,}800 + 5230}{2} = 12{,}015 \text{ psi}$$

$$\frac{S_H + S_T}{2} = \frac{18{,}800 + 6350}{2} = 12{,}575 \text{ psi}$$

Both values are below the allowable stress of 15,000 psi.

Where

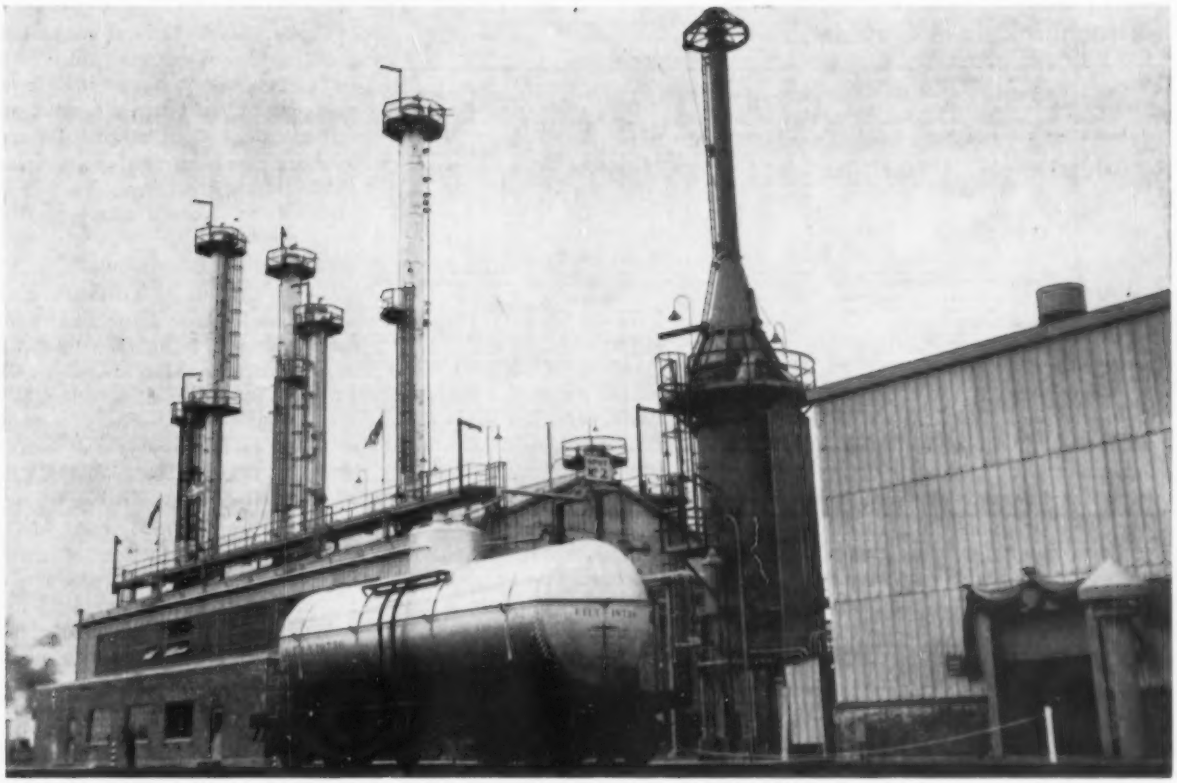
A = outside diameter of flange, inches
$A_b$ = total cross-sectional root area of bolts, sq. in.
$A_m$ = required bolt area, sq. in.
b = effective gasket seating width, inches
B = inside diameter of flange (corroded), inches
C = bolt circle diameter, inches
$d = \frac{U}{V} h_o g_o^2$
$e = F/h_o$
f = hub stress correction factor obtained from Figure W-317.2
F = factor obtained from Figure W-317.4
$g_1$ = thickness of hub at back of flange (corroded), inches
$g_o$ = thickness of hub at small end (corroded), inches
G = mean diameter of gasket, inches
h = hub length, inches
$h_D$ = lever arm for $H_D$, inches
$h_G$ = lever arm for $H_G$, inches
$h_o = \sqrt{Bg_o}$, inches
$h_T$ = lever arm for $H_T$, inches
H = total hydrostatic end force, pounds
$H_D$ = internal pressure component of flange load, pounds
$H_G$ = net gasket load, pounds
$H_p$ = total gasket compression load, pounds
$H_T$ = component flange load resulting from internal pressure acting on annular area between B and G, pounds
$H_y$ = total gasket seating load, pounds
K = A/B
$L = \frac{te + 1}{T} + \frac{t^2}{d}$
m = gasket unit compression factor from Table W-317.1, API-ASME Code
$M_D$ = component flange moment = $H_D h_D$, lb.-in.
$M_G$ = component flange moment = $H_G h_G$, lb.-in.
$M_o$ = total moment acting upon flange, lb.-in.
$M_T$ = component flange moment = $H_T h_T$, lb.-in.
P = design pressure, psi
R = radial distance from bolt circle to point of intersection of hub and back of flange, inches
$S_a$ = maximum allowable bolt stress value at atmospheric temperature, psi
$S_b$ = maximum allowable bolt stress value at operating temperature, psi
$S_f$ = allowable working stress of flange material, psi
$S_H$ = longitudinal stress in hub, psi
$S_R$ = radial stress in flange, psi
$S_T$ = tangential stress in flange, psi
t = flange thickness without corrosion allowance, inches
T = factor obtained from Figure W-317.3
U = factor obtained from Figure W-317.3
V = factor obtained from Figure W-317.4
W = flange design bolt load, pounds
$W_{m1}$ = required bolt load for maximum operating conditions, pounds
$W_{m2}$ = required bolt load for atmospheric temperature conditions without internal pressure, pounds
y = gasket unit seating load, psi
Y = factor obtained from Figure W-317.3
Z = factor obtained from Figure W-317.3

*End of Part 4. End of series.*

EDITOR'S NOTE

An acknowledgment and a complete list of Literature Cited appeared with Part 1 of this series in the August, 1955, REFINER, Page 100.

**Reprints of this series will soon be available for $1 each. Send your order and remittance directly to the author, Daniel A. Donohue, Chemical Construction Corporation, 488 Madison Avenue, New York 28, N. Y.**



Shell Oil Company of Canada, Ltd. isopropyl alcohol plant.

# Petrochemicals in Canada

**In just a little more than a single decade Canada had made remarkable growth as a petrochemical-producing country. Here is the complete story behind that development.**

**A. W. Hutchison and R. G. Stevens**
Shell Oil Company of Canada, Ltd.
Toronto

THE SPAN of petrochemical developments in Canada covers little more than a decade. This period, significant in Canada's history, witnessed a steady, widespread industrial growth of the country, making it the sixth largest manufacturing nation in the world.

The marked and accelerating trend towards urbanization and industrialization, which became apparent in the early 1940's, rapidly changed the nature of the Canadian economy. Major expansions in the manufacturing, dependent on abundant hydroelectric power and a wealth of raw materials, established a basis of demand for chemicals and other industrial products, which has continued to grow remarkably up to the present time.

**Raw Materials**—The petrochemical industry depends for its chief raw materials on two sources, hydrocarbon gases from oil refining operations and natural gas. In the industrial centers of the country are located two of the most important refining areas in Canada—Sarnia, Ontario and Montreal, Quebec.

Crude charge to refineries in these two areas has increased from 101,500 barrels per day in 1939 to 294,000 barrels per day in 1954. This increase in crude runs has made possible increased petrochemical raw materials and accounted for some of the expansion and location of chemical plants in these two areas during the past ten years.

Canada's natural gas reserves are located chiefly in Alberta. At the end of 1953 these reserves were estimated at 13.4 trillion cubic feet. The availability of this cheap gas has helped the problem of long distances from markets and offered incentive for establishment of petrochemical industry in the west.

**Locations and Growth**—In the past, Canada's limited population and modest degree of industrialization did not justify the construction of many large chemical plants. Do-

**TABLE 1—Petrochemical Manufacturers in Canada, Plant Investments, and Main Petrochemical Products**

| COMPANY | Plant Investment at End—1953 ($ million) | Acetaldehyde | Acetic Acid | Acetone | Ammonia | Carbon Blacks | Carbon Tetrachloride | Ethylene Glycol | Formaldehyde | Latex, Synthetic | Methyl Alcohol | Pentaerythritol | Phenol | Polyethylene | Polystyrene | n-Propyl Alcohol | iso-Propyl Alcohol | Propylene Glycol | Rubber, Synthetic | Styrene Monomer | Sulfur | Trichloroethylene |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Bakelite Co. (Canada) | 1½ | | | | | | | | × | | | | | | | | | | | | | |
| B. A. — Shawinigan | 4 | | | × | | | | | | | | | × | | | | | | | | | |
| Cabot Carbon of Canada, Ltd. | 3½ | | | | | × | | | | | | | | | | | | | | | | |
| Canadian Chemical Co. | 70 | × | × | × | | | | | × | | × | × | | | | × | | × | | | | |
| Canadian Industries (1954) | 14 | | | | | | | | | | | | | × | | | | | | | | |
| Consolidated Mining & Smelting Co. | 11 | | | | × | | | | | | | | | | | | | | | | | |
| Dominion Tar & Chemical Co. | 12 | | | | | | | × | | | | | | | | | | × | | | | |
| Dow Chemical of Canada | 36 | | | | × | | × | × | | × | | | | | × | | | | × | | × | × |
| Monsanto (Canada) | 1 | | | | | | | | | | | | | | × | | | | | | | |
| Polymer Corporation | 69 | | | | | | | | | × | | | | | | | | | × | × | | |
| Royalite Oil Co. | ½ | | | | | | | | | | | | | | | | | | | | × | |
| St. Maurice Chemicals | 3 | | | | | | | | × | | | × | | | | | | | | | | |
| Shell Oil Co. of Canada, Ltd | 5 | | | × | | | | | | | | | | | | | × | | | | × | |
| Sherritt-Gordan Mines | 5 | | | | × | | | | | | | | | | | | | | | | | |

mestic demands for many commodities simply did not reach volumes which would support a minimum size plant, particularly for petrochemical production. This era ended some 12 years ago for petrochemicals with Canada's first manufacturing venture in that field.

The development of this new industry was rapid and multiple plants are now located at Edmonton, Calgary, Sarnia and Montreal. Capital investment has reached approximately $235 million. The average growth since 1945 has been at the rate of about 18 percent per year.

Some 50 petrochemicals are now being produced commercially in Canada by about 15 companies. Table 1 shows some of the main products and the names of the firms making them.

**Sarnia—Canada's Chemical Valley—Synthetic Rubber.** Canada's entry into the petrochemical field started in September 1943 with the completion of a synthetic rubber plant. The Polymer Corporation (operated by Dow Chemical of Canada) has grown to a capacity of 90 million pounds of synthetic rubber annually. Of this production ⅚ is GR-S and ⅙ butyl.

The various intermediates available from this rubber plant promoted the post-war growth of the petrochemical industry in Sarnia. Dow of Canada purchased a site adjacent to the rubber plant and built a plant for polystyrene production. In 1948 Dow completed the construction of an ethylene glycol plant using ethylene available from the rubber plant.

These facilities gave Dow a capacity of 9000 short tons a year of total glycol production. The principal use of ethylene glycol in Canada is antifreeze compounds although about ⅕ goes into making dynamite, alkyd resins and other end-products.

**Carbon Tetrachloride, Trichloroethylene and Perchloroethylene.** Since the ethylene glycol process used by Dow was the well-known chlorohydrin method approximately 1 pound of ethylene dichloride by-product was stored for every 3 pounds of ethylene glycol produced. This byproduct had very little market but with the development, by Dow, for production from ethylene dichloride of carbon tetrachloride, trichloroethylene and perchloroethylene with hydrochloric acid as a byproduct this foresight in storage of ethylene dichloride became evident.

**Ammonia.** An ammonia plant was completed in 1952 using hydrogen from local refineries and byproduct hydrogen from caustic soda-chlorine cells. This plant has grown from 15 tons per day to 90 tons per day.

**Ethylene.** Because most of the petrochemical products manufactured by Dow were based on ethylene, a 50 ton-per-day ethylene plant was constructed in 1951 using feed stocks from the oil refinery of Canadian Oil Companies. In addition to this Dow erected in 1953 a styrene monomer plant having a capacity of 1000 tons per month. This made Dow completely self sufficient in its requirements for polystyrene manufacture.

Since Dow's first venture into this field with an investment of $15 million it has grown to a total of $36 million in 1953.

**Carbon Black.** Natural gas was the traditional raw material for producing carbon blacks, but in 1943 it was discovered that highly reinforcing carbon blacks could be manufactured satisfactorily from readily transportable liquid hydrocarbons. This served to move the carbon black plants from the gas fields to sites near the refineries and the rubber plants.

Cabot Carbon of Canada's plant was located at Sarnia because of the local refineries being able to supply the hydrocarbon raw materials. In June, 1953, at a cost of $3.4 million, a plant was opened with a capacity of 17,500 short tons a year of furnace blacks of the high abrasion (H.A.F.) and fast extruding (F.E.F.) types.

By the end of 1953, total investment in the production of petrochemicals and associated products at Sarnia had risen to about $109 million, which represented nearly half of the figure for Canada as a whole.

**Petrochemical Manufacture at Montreal**—The manufacture of petrochemicals at Montreal did not begin until 1953, when four plants representing a captial investment of $24 million were opened within a few months of each other.

**Isopropyl Alcohol and Acetone.** Shell Oil Company of Canada opened the first of these plants adjacent to its Montreal East refinery in April, 1953 to produce isopropyl alcohol and acetone. Built at a cost of $4.8 million these facilities have an annual capacity of 6000 short tons of isopropyl alcohol and 4000 short tons of acetone. In the isopropyl alcohol process byproducts propane-propylene from the refinery is used. Unreacted propane is purified and subsequently sold as liquified petroleum gas. Acetone is made by catalytically dehydrogenating isopropyl alcohol.

**Phenol and Acetone.** B. A.-Shawinigan opened in May, 1953, a plant to produce phenol and acetone from cumene. This plant cost $4 million with a capacity of 6500 short tons of phenol and 4000 tons of acetone a year.

**Cumene.** British-American Oil refinery at Montreal East manufactures the cumene raw material by alkylation of benzene. These facilities have a capacity of 210,000 barrels or 32,000 short tons a year of cumene.

**Formaldehyde and Pentaerythritol.** St. Maurice Chemicals (a joint sub-

sidiary of Shawinigan Chemicals and Heyden Chemical Corporation) opened its plant in September, 1953, for the manufacture of formaldehyde and pentaerythritol, using as a raw material synthetic methanol obtained from Canadian and U. S. sources. Located on the south shore of the St. Lawrence River at Varennes, Quebec, it has an annual capacity of 15,000 short tons of formaldehyde and pentaerythritol.

**Glycols.** In May, 1953, Dominion Tar and Chemical Company completed a plant at Montreal East to make ethylene from petroleum refinery gases. The products, using the chlorohydrin process, are ethylene oxide, ethylene glycol, propylene oxide, propylene glycol and chlorinated products, such as ethylene dichloride. The plant cost $12.4 million and has an output of about 15,000 short tons a year of total glycols.

**Developments in the West—Alberta**—Of the six petrochemical plants in Alberta, five use natural gas as a raw material. The sixth, which is Canadian Chemical Company, uses direct oxidation of $C_3$ and $C_4$ hydrocarbon gases derived from local oil refineries and natural gas plants. It produces a wide range of oxygenated chemicals, mainly alcohols, aldehydes, ketones and acids. In terms of investment, this is the most important petrochemical plant in Western Canada.

**Acetaldehyde, Acetic Acid, Formaldehyde, Methanol, Acetone, Propylene Glycol and n-Propanol.** Canadian Chemical Company (an affiliate of Celanese Corporation of America) completed at Edmonton in August, 1953, at a cost of approximately $70 million a chemical and cellulose acetate plant having an annual capacity of 12,500 short tons of cellulose acetate and 8,500 short tons of pentaerythritol in addition to unreported production of oxygenated hydrocarbon chemicals. Of these chemicals the major products are acetaldehyde, acetic acid, formaldehyde, methanol, acetone, propylene glycol and n-propanol. Of lesser importance in the operation are n-propyl acetate, dipropylene glycol, n-butanol, isobutanol and acetic anhydride.

**Polyethlene.** Because it was doubtful whether oil refineries in Eastern Canada would be able to supply, over a long term, the large quantities of ethylene needed as a raw material Canada's first polyethylene plant was built in Edmonton. Natural gas was available cheaply near the Edmonton site so that low raw materials costs balanced out the freight rate to the main consumers in Eastern Canada.

The plant opened in October, 1953 at a cost of $14 million is owned by Canadian Industries. The original capacity was 6000 short tons of polyethylene a year. It has been enlarged since. At the plant, ethane is cracked to ethylene by thermal degradation, using the Imperial Chemical Industries process. The polymerization process is carried out at approximately 20,000 pounds per square inch.

**Ammonia and Ammonium Nitrate.** In October, 1941, an ammonia plant having a capacity of 150 tons a day was completed at Calagry, using natural gas as the raw material. The plant is owned by Consolidated Mining and Smelting Company, and while the original investment was $9.8 million with a capacity of 150 tons per day it has now been expanded to a daily capacity of 260 short tons of ammonia and 200 tons of ammonium nitrate. Additional expansion was announced in 1954 and the addition of a urea plant is also planned.

Sherritt-Gordan Mines has announced the erection of a plant in Alberta to manufacture ammonia and hydrogen from natural gas. This plant will have a daily capacity of 75 tons of anhydrous ammonia and 2 tons of hydrogen and will cost $5 million.

**Sulfur.** Sulfur plants, manufacturing sulfur from hydrogen sulfide present as an impurity in natural gas are operated in Alberta by Shell Oil Company of Canada, at Jumping Pound, and by Royalite Oil Company, in the Turner Valley, near Calgary. Shell's original plant costs $500,000 and produced 10,000 short tons a year but additional expansion has been made to bring this up to 21,000 short tons a year. Royalite Oil Company completed in July, 1952, a 10,000 short tons a year plant.

The most important problems now confronting petroleum chemical manufacturers in Canada are those of a small although expanding market, the total requirements of which are often less than the production of a plant of minimum economic size. As the significance of this limitation diminishes for an increasing number of products, refinery gases and natural gas and its associated hydrocarbons will find greater use as raw materials for petrochemical units. Over the next few years, therefore, we may expect the progressive establishment of petrochemical processes not yet introduced to Canada, and the extension of present processes to make derivatives of what is still a limited range of chemicals basic to a petrochemical industry.

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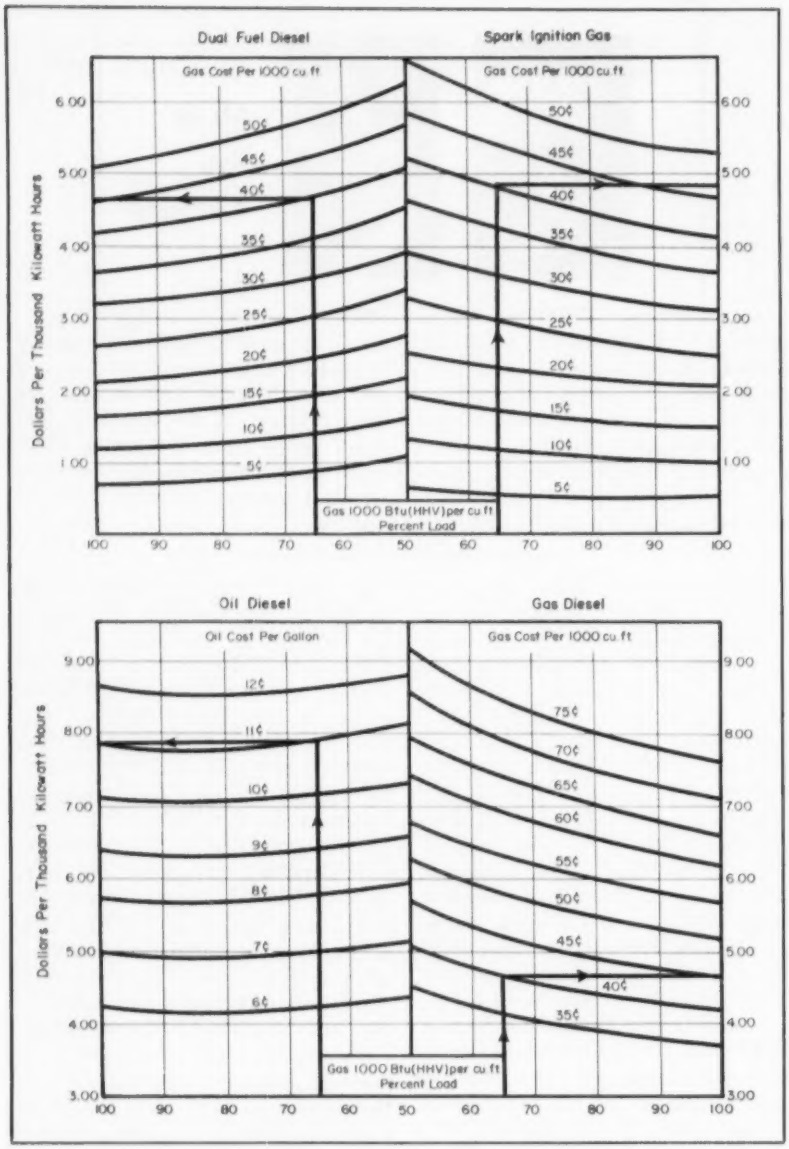
Dual Fuel Diesel
Spark Ignition Gas
Gas Cost Per 1000 cu ft
Gas Cost Per 1000 cu ft
Dollars Per Thousand Kilowatt Hours
Gas 1000 Btu(HHV)per cu ft
Percent Load
Oil Diesel
Gas Diesel
Oil Cost Per Gallon
Gas Cost Per 1000 cu ft
Dollars Per Thousand Kilowatt Hours
Gas 1000 Btu(HHV)per cu ft
Percent Load

# Compare Engine Fuel Costs

**Volney M. Holmes**
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Buffalo, N. Y.

**ENGINEERS** concerned with selecting the most economical type of engine for a given application will find these fuel-cost charts helpful. They compare the relative costs among oil diesel, dual fuel diesel, gas diesel and spark ignition engines. In all cases, lubricating oil cost can be calculated by estimating lubricating oil consumption at 4000 rated horsepower hours per gallon.

Fuel costs for dual fuel diesel and gas diesel include 19,350 Btu (HHV) per pound of *pilot oil* at *ten cents* per gallon. For each cent that pilot oil varies from ten cents per gallon, add or deduct the following amounts to or from the cost shown per thousand kilowatt hours for dual fuel and gas diesels: (a) full load, 2.6 cents;
(b) ¾ load, 3.4 cents;
(c) ½ load, 5.0 cents.

**Example:** If diesel fuel oil is available at a price of 11 cents per gallon and natural gas at a price of 40 cents per thousand cubic feet, what is the best engine selection? The average load is assumed to be 65 percent of full load.

**Solution:** First, refer to the charts titled, "Dual Fuel Diesel" and "Gas Diesel." Follow the arrows and the cost of fuel oil is found to be $4.70, based on pilot oil at 10 cents per gallon. For 11 cent pilot oil, the total correction will be plus 4 cents. Therefore, the total cost of gas and pilot oil per thousand kilowatt hours will be

$$\$4.70 + .04 = \$4.74.$$

The "Spark Ignition Gas" chart shows that fuel for this engine at 65 percent load factor is $4.80.

Similarly, referring to the "Oil Diesel" chart, oil for this type of engine costs $7.85. In this instance, the dual fuel diesel, generating power at a cost of 4.74 mils per kilowatt-hour, is the best selection. Not only is the fuel cost less, but in case of gas failure, it can be changed over instantly to operation on 100 percent oil. When equipped with automatic changeover devices, the engine will automatically go from gas to oil under load.

If oil costs 8 cents per gallon and gas is 20 cents per thousand cubic feet, comparative fuel costs per thousand kilowatt hours are as follows:

| | |
|---|---|
| Dual Fuel $\$2.55 - (2 \times .04)$ | = $2.47 |
| Spark Ignition | = $2.40 |
| Oil Diesel | = $5.70 |

In this instance, the spark ignition engines produce the lowest fuel cost by a slight margin compared to dual fuel.

If gas at this price of 20 cents per thousand represents a dumpload rate, then consideration should be given to either a dual fuel or a tri-power engine. In this case, the final decision will depend upon other factors that may be evaluated in addition to the cost of fuel.

It will pay to check local fuel costs. If you are not now using the most economical fuel in your engine, it may be converted to a lower priced fuel for additional savings.

Get away from integral calculus
by this practical simplification of . . .

# Thermodynamics for Process Evaluation

- **Thermodynamics is a good means of evaluating a process.**
- **Too frequently it involves difficult calculations.**
- **Van Ness simplifies these calculations.**

**Hendrick C. Van Ness**
Purdue University
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MANY PRACTICING engineers perhaps fail to realize the usefulness of the second law of thermodynamics for solving practical problems. This may come about from the apprehension and frustration which usually accompanies the student's introduction to this universal law. An approach not generally appreciated by engineers is explained in this article.

**Ideal Work**—We shall first derive an expression for what will be called ideal work or $W_{ideal}$, the minimum work *required* to bring about a given change or the maximum work which can be *produced* by a given change. Since we are interested in the ideal case, it is necessary to consider a process that is reversible in all respects. In this case the second law requires for a differential change that $dS_{total} = 0$.

In a thermodynamic analysis we usually consider the sphere of influence of a process to be divided into two parts, the system, in which the process actually occurs, and the surroundings, which includes all else. We may therefore divide $dS_{total}$ into two parts, and write,

$$dS + dS_{surr} = 0 \qquad (1)$$

In this paper symbols without an identifying subscript will refer to the *system*. Thus in Equation 1, dS represents a differential change in the entropy of the system and $dS_{surr}$ represents an accompanying entropy change of the surroundings, and their sum is $dS_{total}$.

Since the process occurs entirely within the system, the only entropy changes which can occur in the surroundings are those which result from the transfer of heat to it from the system or vice versa. Thus we may write, $dS_{surr} = dQ_{surr}/T_o$, where $dQ_{surr}$ represents a differential amount of heat added to the surroundings, and $T_o$ represents the absolute temperature of the surroundings. Heat added to the surroundings must be equal to the heat extracted from the system and vice versa, but they are given opposite signs because heat added is regarded as positive and heat extracted as negative. Thus, $dQ_{surr} = -dQ$ and $dS_{surr} = -dQ/T_o$. Substituting for $dS_{surr}$ in Equation 1, we get,

$$dS - dQ/T_o = 0, \text{ or}$$
$$dQ = T_o dS \qquad (2)$$

At first glance it may appear that this equation is contrary to the well-known expression for a reversible process, $dQ = TdS$, where T is the absolute temperature of the system. It must be remembered, however, that we have assumed reversibility in *all* respects, including reversible heat transfer between the system and the surroundings. Reversible heat transfer can occur only when a differential temperature difference is the driving force. Thus the temperature of that *part* of the system which exchanges heat with the surroundings must also be $T_o$.

We may also write the first law for the system under consideration. For a non-flow process

$$dE = dQ - dW \qquad (3)$$

Substituting for dQ by Equation 2 and solving for dW, we get

$$dW = T_o dS - dE \qquad (4)$$

where dW is the work done by or on the system (according to the usual convention it will be positive in the former case and negative in the latter), dS and dE are the entropy and internal energy changes of the system, and $T_o$ is the absolute temperature of the surroundings.

In a non-flow process, the system may expand or contract, doing work on the atmosphere or receiving work from the atmosphere. In the former case such work cannot be used, but must be unavoidable expended; in the latter case it is free and need not be charged to the cost of operating the process. Thus to obtain what we will call the ideal work, we must substract from Equation 4 the work exchanged with the surrounding atmosphere, $p_o dV$, where $p_o$ is usually atmospheric pressure and dV is the volume change of the system. Equation 4 then becomes:

$$dW_{ideal} = T_o dS - dE - p_o dV \qquad (5)$$

If no volume change occurs, then the last term of this equation is zero, and we have,

$$dW_{ideal} = T_o dS - dE \qquad (6)$$

As a matter of fact, Equation 5 is rarely of practical importance; it is rather Equation 6 which is sometimes useful.

This equation in one form or the other gives the ideal work for a differential non-flow process because it represents the maximum useful work which may be obtained from a work-producing process or the minimum work which must be expended for a work-requiring process. More important in practice is the steady-state flow process. In this case the first law is written,

$$dH = dQ - dW \qquad (7)$$

We have neglected here both kinetic

and potential energy effects, as they are usually negligible when compared with the heat and work terms in most operations considered by chemical engineers other than fluid flow.

Proceeding in a manner analogous to that used to derive Equation 4, we get for the steady-flow process,

$$dW = T_o dS - dH$$

In this case the question of work done on or by the atmosphere does not arise because such effects have already been included in the dH term. Thus the above equation gives directly the differential of the ideal work for a steady-flow process, and we write,

$$dW_{ideal} = T_o dS - dH \qquad (8)$$

We will consider the integration of Equations 6 and 8 later, but now we will turn our attention to another concept, that of lost work or $W_{lost}$.

**Lost Work**—We have dealt with the reversible process in deriving equations for ideal work. But actual processes are irreversible, and every irreversibility results in lost work. Thus processes which produce work deliver less work than the ideal, and processes which require work must be supplied with more than the ideal. The expression for lost work is the same for all processes, flow or non-flow, and is best derived with reference to the non-flow case.

Suppose that some irreversible process causes a differential change within the system. For such a process we may write the first law, $dE = dQ - dW$ (Equation 3). In addition we note that the entropy change of the surroundings at $T_o$ is given by,

$$dS_{surr} = \frac{dQ_{surr}}{T_o} = -dQ/T_o \qquad (9)$$

Now let the *system* be restored to its original state by a *completely reversible* process. Again we write the first law,

$$dE_{rev} = dQ_{rev} - dW_{rev} \qquad (10)$$

And again we note that the entropy change of the surroundings at $T_o$ is given by

$$dS_{surr,\ rev} = \frac{-dQ_{rev}}{T_o} \qquad (11)$$

For the complete cycle—original process plus reversible restoration—we may add Equations 3 and 10, and write,

$$dE + dE_{rev} = dQ - dW + (dQ_{rev} - dW_{rev}) \qquad (12)$$

But for the complete cycle there can be no net change in the internal energy of the system because it has been returned to its original state. Thus $dE + dE_{rev} = 0$. Moreover, there can be no net change in the entropy of the system for the same reason. Therefore the total entropy change which occurs during the complete cycle is the sum of the entropy changes occurring in the surroundings during the two processes. Adding Equations 9 and 11, we get,

$$dS_{total} = \frac{-(dQ + dQ_{rev})}{T_o} \qquad (13)$$

If this is the total entropy change for the *cycle* it must also be the total entropy change for the initial irreversible process, for the restoration process was taken to be completely reversible and results in no change in total entropy. The total entropy change accompanying the original irreversible process is therefore given by Equation 13.

Since the left-hand side of Equation 12 is zero, it may be written,

$$dW + dW_{rev} = dQ + dQ_{rev} \qquad (14)$$

Combining Equations 13 and 14, we get,

$$dW + dW_{rev} = -T_o dS_{total} \qquad (15)$$

In Equation 15 the left-hand side represents the net work of the cycle. In other words it is the *extra* work required to restore the system to its original state, and is therefore lost work, for if the original process had been reversible, no *extra* work would have been required to restore the system by a reversible process. This extra work therefore represents work which could have been obtained in the original process had it been reversible but which was lost because of its irreversibility. We may now write Equation 15 as

$$dW_{lost} = -T_o dS_{total} \qquad (16)$$

In this equation $dS_{total}$ is the entropy change of the system *and* surroundings which occurs during any irreversible process. While it has been derived for a non-flow process, it holds also for flow processes as may be shown by an entirely analagous derivation. Equation 16 may be put in another form which is usually more convenient. Since,

$$dS_{total} = dS + \frac{dQ_{surr}}{T_o} = dS - dQ/T_o$$

Then

$$dW_{lost} = dQ - T_o dS \qquad (17)$$

where dS and dQ refer to the system. From the above discussion it should be clear that the actual work of any process is the sum of the ideal work and the lost work. Thus we may write,

$$dW = dW_{ideal} + dW_{lost} \qquad (18)$$

**Practical Simplifications**—Two problems remain to be discussed before these equations can be put in their final form, ready for practical use. These are the problem of integration and the problem of what values $T_o$ may assume. That these are related problems may be seen from the fact that in the above equations only the integration of the $T_o dS$ terms could be open to question. dW and dQ integrate to give W and Q, and dE and dH, being point functions, integrate to $\Delta E$ and $\Delta H$. But how shall we evaluate $\int_1^2 T_o dS$? Clearly this problem revolves around the question of the values or value of $T_o$. If $T_o$ is constant, integration gives $T_o \Delta S$, but the question remains as to what value to choose for $T_o$. If $T_o$ is to vary, the question of how it varies must be answered.

Actually, one has almost free choice over the value or values of $T_o$ so long as he is consistent within a given problem. To understand this, one must first realize that a given change within a system may be carried out regardless of the temperature of the surroundings. It is apparent, however, from Equations 6 and 8, and

## Meet the Author

HENDRICK C. VAN NESS, who teaches a graduate course for chemical engineering students at Purdue University, has been an assistant professor at the university since 1952. Previously associated with The M. W. Kellogg Company, Dr. Van Ness entered Yale University to begin studying for his doctorate in 1949. While at Yale he held an AEC fellowship for two years, working on the effects of hydrogen on metals at high pressures. Dr. Van Ness first started teaching at his Alma Mater, the University of Rochester, where he completed his master's degree in chemical engineering while serving as an instructor in engineering. He is a licensed engineer in New York.

17 that $W_{ideal}$ and $W_{lost}$ depend on the value of $T_o$. In fact it is convenient when speaking of ideal work or lost work to regard them as being *with respect to* some particular temperature. In theory we could calculate ideal work and lost work with respect to any temperature, but such calculations would serve little purpose. In effect they postulate the existence of imaginary surroundings, whereas for most practical purposes calculations should be based on approximate ambient temperatures. This usually means that we take ideal work and lost work with respect to the temperature at which nature forces us to discard heat—either the temperature of the atmosphere or the temperature of the cooling water available. Neither of these is actually constant, but for practical purposes we ordinarily consider the worst possible case, and choose $T_o$ constant at the highest temperature at which we are forced to reject heat. It would be possible to allow $T_o$ to vary, but this would greatly complicate the calculations and would require a relationship between $T_o$ and S for the integration of $\int_1^2 T_o dS$.

When $T_o$ is taken as constant (usually at the maximum temperature at which heat must be rejected), Equations 6, 8, 17, and 18 integrate easily to give:

Non-flow process (no volume change):

$$W_{ideal} = T_o\Delta S - \Delta E \qquad (19)$$

Steady-flow process (negligible potential and kinetic energy effects):

$$W_{ideal} = T_o\Delta S - \Delta H \qquad (20)$$

Any process:

$$W_{lost} = Q - T_o\Delta S \qquad (21)$$

$$W = W_{ideal} + W_{lost} \qquad (22)$$

For most actual processes it is desirable to calculate lost work in parts so that the loss occurring in each part of the process may be determined. In this case Equation 22 is written,

$$W = W_{ideal} + \Sigma W_{lost} \qquad (23)$$

and Equation 21 is applied separately to each part of the process. The actual work may then be divided into the ideal work and the work lost in each part of the process. In this way one may analyze a process to see exactly what part of the actual work goes into accomplishing the desired change and what part of the actual work is lost in each part of the process because of its irreversibility or inefficiency. It should be noted that Equation 23 is not ordinarily used to calculate the actual work of a process, but rather provides a check on the calculations.

The thermodynamic efficiency of a work-requiring process is defined as the ratio of the ideal work to the actual work,

$$\text{Thermodynamic Efficiency} = W_{ideal}/W \quad \text{(work required)} \qquad (24)$$

For a work-producing process the thermodynamic efficiency is defined as the ratio of the actual work to the ideal work,

$$\text{Thermodynamic Efficiency} = W/W_{ideal} \quad \text{(work produced)} \qquad (25)$$

For a given value of $T_o$ it will be seen that Equations 19 and 20 for the calculation of ideal work depend only on property changes of the system. Since this is the case, $W_{ideal}$ might well be regarded as a property change itself, for its value is clearly independent of the path taken to accomplish a given change in the system. This, indeed, is the approach taken by Keenan[2] and other authors, who have called this quantity a change in availability. We have preferred, however, to deal with work terms, for the mind seems more readily to grasp the concept of work than the more abstract notion of a property.

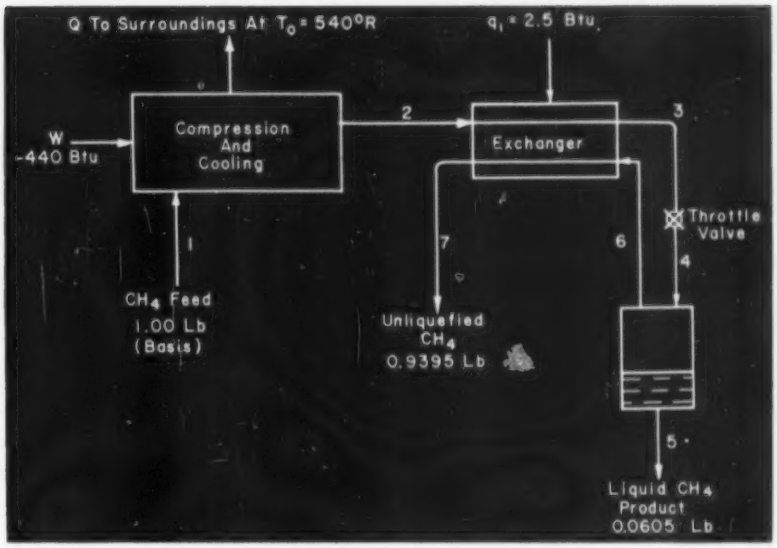


**FIGURE 1—Simple evaluation of the Linde system for the liquefaction of methane.**

**TABLE 1—Data for Illustration 1**

| Point | State of the $CH_4$ | Temp. °F. | Pressure psia. | Enthalpy Btu./lb. | Entropy Btu./lb.-°R |
|---|---|---|---|---|---|
| 1 | Superheated vapor | 80.0 | 14.7 | 410.4 | 1.6890 |
| 2 | Superheated vapor | 80.0 | 1000 | 381.6 | 1.1273 |
| 3 | Superheated vapor | −88.0 | 1000 | 223.6 | 0.7725 |
| 4 | Wet vapor | −258.6 | 14.7 | 223.6 | 1.1118 |
| 5 | Saturated liquid | −258.6 | 14.7 | 17.7 | 0.0877 |
| 6 | Saturated vapor | −258.6 | 14.7 | 236.9 | 1.1777 |
| 7 | Superheated vapor | 75.0 | 14.7 | 407.7 | 1.6840 |

**Illustration 1**—Methane is to be liquefied by a simple Linde system as shown in Figure 1. The methane is taken into the system at 1 atm. abs. and 80 F., compressed to 1000 psia, and cooled again to 80 F. The product is saturated liquid methane at 1 atm. abs. The unliquefied methane, also at one atm. abs., is returned through a heat exchanger where it is heated to 75 F. by the high-pressure methane. A heat leak into the exchanger of 2.5 Btu will be assumed for each pound of methane entering the compressor. Heat leaks to other parts of the apparatus will be assumed negligible.

Make a thermodynamic analysis of the process, i.e., determine the thermodynamic efficiency of the process, and calculate the lost work in each step of the process.

**Solution**—For most practical problems the exact value chosen for $T_o$ makes little difference so long as it is approximately the ambient temperature. In this solution we will assume $T_o$ to be 80 F. or 540 R. Methane compression from 14.7 to 1000 psia will be assumed to be carried out in a 3-stage machine with complete intercooling having an efficiency of 75 percent. The actual work for this compression has been calculated with the aid of a pressure-enthalpy diagram[4] for methane to be 440 Btu per pound of methane. The fraction of the entering methane that is liquefied is readily calculated to be 0.0605 by an appropriate energy balance (see, for example, Dodge[1] 462). The properties at various points in the process have been calculated by the usual methods, and are given in Table 1. The data were taken from Matthews and Hurd.[4] The basis for all calculations is 1 pound of methane entering the process.

To calculate Q, we apply the first law

to the compression and cooling system,

$$Q = \Delta H + W = (381.6 - 410.4) - 440.0 = -468.8 \text{ Btu.}$$

The system is comprised of the methane and the equipment which contains it. Since the equipment undergoes no change, only the methane must be considered in calculating the ideal work. This is done by Equation 20 applied to the overall process.

$$W_{ideal} = T_o\Delta S - \Delta H = 540\ [(0.0605)(0.0877) + (0.9395)(1.6840) - 1.6890] - [(0.0605)(17.7) + (0.9395)(407.7) - 410.4]$$

$$W_{ideal} = -28.6 \text{ Btu}$$

The various lost work terms are calculated by Equation 21 applied to each part of the process separately. For the compression and cooling system,

$$W_{lost} = Q - T_o\Delta S = -468.8 - 540(1.1273 - 1.6890) = -165.5 \text{ Btu.}$$

For the exchanger,

$$W_{lost} = 2.5 - 540\ [(0.9395)(1.6840 - 1.1777) + (0.7725 - 1.1273)]$$

$$W_{lost} = -62.8 \text{ Btu}$$

For the throttle valve,

$$W_{lost} = 0 - 540\ (1.1118 - 0.7725) = -183.2 \text{ Btu.}$$

These results are summarized in Table 2.

As required by Equation 23, the sum of the first column of figures in Table 2 is the actual work, and from Equation 24 the first figure of the second column is the thermodynamic efficiency of the process.

The largest loss occurs in the throttling process. By eliminating this completely irreversible process in favor of an expansion engine, processes of considerably increased efficiency can be designed.

**Illustration 2**—Consider the operation of a simple power cycle, generating steam to run a steam turbine under the following conditions: The fuel is to be coke (considered pure carbon in these calculations), and it is to be burned completely to $CO_2$ using 20 percent excess air. Steam will be generated at 500 psia and superheated to 900 F. The turbine will have an efficiency of 75 percent compared with an isentropic turbine, and it will exhaust to a condenser at 1 psia. It will be assumed that no subcooling of the condensate occurs in the condenser and that the condensate is returned to the boiler directly. The work of pumping the condensate to the boiler will be considered negligible. The stack gas from the furnace will have a temperature of 500 F., and cooling water will be available at 77 F.

**TABLE 2—Summary of Results for Illustration 1**

| | Btu./lb. $CH_4$ | Percent of W |
|---|---|---|
| Ideal Work | — 28.6 | 6.5 |
| Loss in Compression and Cooling | —165.5 | 37.6 |
| Loss in Exchanger | — 62.8 | 14.3 |
| Loss in Throttling | —183.2 | 41.6 |
| Total (W) | —440.1 | 100.0 |

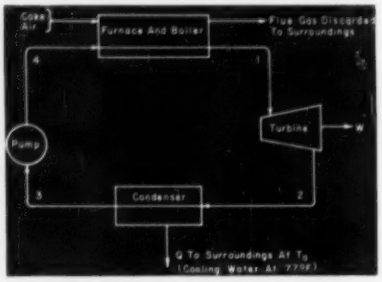


**FIGURE 2—Simplification as applied to steam power cycle.**

**Solution**—The power cycle is represented in Figure 2, and conditions at various points of the cycle are given in Table 3. Data were taken from Keenan and Keyes.[3]

The system consists of the material passing through the furnace, i.e., the coke and air and the combustion products, and the steam cycle. The cycle, however, remains invariant, and the only changes which need be considered for the calculation of ideal work are in the material passing through the furnace. In an ideal process the flue gases would be cooled to the temperature of the surroundings before leaving the system. Thus for the calculation of ideal work we have for the property changes of the system only the *isothermal* $\Delta H$ and $\Delta S$ values for the combustion process. This assumes that the coke and air are also at $T_o$, an assumption that cannot be far from right.

The reaction occurring is, $C + O_2 = CO_2$. For this reaction at 77 F. (25 C.) we have from Perry,[5]

$$\Delta H = -94{,}050 \text{ cal/gm-mole} = -169{,}290 \text{ Btu/lb-mole.}$$

$$\Delta F = -94{,}260 \text{ cal/gm-mole}$$

Since $\Delta F = \Delta H - T\Delta S$ for an isothermal process,

$$\Delta S = (\Delta H - \Delta F)/T = (-94{,}050 + 94{,}260)/298 = 0.705 \text{ Btu/lb-mole °R.}$$

$T_o = 537$ R; therefore,

$$W_{ideal} = T_o\Delta S - \Delta H = (537)(0.705) + 169{,}290 = 169{,}670 \text{ Btu/lb-mole.}$$

We will take as a basis for all calculations one lb-mole of carbon burned. The air supplied to the furnace will contain 1.2 lb-moles of $O_2$ and 4.51 lb-moles of $N_2$. The flue gas will contain 1 lb-mole of $CO_2$, 0.2 lb-moles of $O_2$, and 4.51 lb-moles of $N_2$ giving the total moles of flue gas as 5.71 lb-moles.

By discarding the flue gas to the atmosphere at 500 F. we are in effect transferring heat to the surroundings in the amount given off by cooling the flue gases from 500 to 77 F. Since the average heat capacity of the flue gases is 7.5 Btu/lb-mole °F, the heat rejected amounts to,

$$Q_{fg} = \Delta H = nC_p\Delta t = (5.71)(7.5)(77 - 500) = -18{,}100 \text{ Btu.}$$

The heat used to generate steam is the heat of reaction ($\Delta H$ of reaction) minus the heat lost up the stack, or

$$169{,}290 - 18{,}100 = 151{,}190 \text{ Btu}$$

The amount of steam generated is then

$$\frac{151{,}190}{1466.0 - 69.7} = 108.28 \text{ lb.}$$

The work produced by the turbine is

$$W = (108.28)(1466.0 - 1078.0) = 42{,}010 \text{ Btu}$$

The heat rejected in the condenser is,

$$Q = (108.28)(69.7 - 1078.0) = -109{,}180 \text{ Btu}$$

We may now calculate the lost work in the various parts of the process. For the furnace and boiler,

$$W_{lost} = Q - T_o\Delta S = -18{,}100 - (537)[(108.28)(1.6982 - 0.1326) + 0.705]$$

$$W_{lost} = -109{,}510 \text{ Btu}$$

For the turbine,

$$W_{lost} = 0 - (537)(108.28)(1.9284 - 1.6982) = -13{,}390 \text{ Btu}$$

For the condenser,

$$W_{lost} = -109{,}180 - (537)(108.28)(0.1326 - 1.9284) = -4760 \text{ Btu.}$$

In this case work is produced, and Equation 23 is best written,

$$W_{ideal} = W - \Sigma W_{lost}$$

The results, which satisfy this equation, are summarized in Table 4.

**TABLE 4—Summary of Results for Illustration 2**

| | Btu./lb.-mole of C Burned | Percent of $W_{ideal}$ |
|---|---|---|
| Actual work | 42,010 | 24.8 |
| $-W_{lost}$ in furnace and boiler | 109,510 | 64.5 |
| $-W_{lost}$ in turbine | 13,390 | 7.9 |
| $-W_{lost}$ in condenser | 4,760 | 2.8 |
| $-W_{lost}$ in pump | neglected | .... |
| Total ($W_{ideal}$) | 169,670 | 100.0 |

Since work is produced, the thermodynamic efficiency of the process is given by Equation 25. From the above table it is evidently 24.8 percent. By far the largest loss occurs in the furnace-boiler unit. The irreversibilities lumped together here include the combustion itself and the heat transfer both to the surroundings (from the discarded flue gases) and between the furnace and the boiler. This loss could have been broken down into its parts if for any reason it were desirable to do so.

## NOMENCLATURE

$C_p$, heat capacity or specific heat at constant pressure.
E, internal energy of the system.
F = H — TS, free energy.
H, enthalpy of the system.
n, number of moles.
$p_o$, absolute pressure of the surroundings.
Q, heat transferred to or from the system.
S, entropy of the system.
t, temperature, °F or °C.
T, absolute temperature of the system.
$T_o$, absolute temperature of the surroundings.
V, volume of the system.
W, actual work done by or on the system.
$W_{ideal}$, ideal work.
$W_{lost}$, lost work.

**TABLE 3—Data for Illustration 2**

| Point | State of the $H_2O$ | Temp. °F. | Pressure psia. | Enthalpy Btu./lb. | Entropy Btu./lb.-°R |
|---|---|---|---|---|---|
| 1 | Superheated vapor | 900 | 500 | 1466.0 | 1.6982 |
| 2 | Wet vapor—(x=0.973) | 101.74 | 1 | 1078.0 | 1.9284 |
| 3 | Saturated liquid | 101.74 | 1 | 69.7 | 0.1326 |
| 4 | Subcooled liquid | 101.74 | 500 | 69.7 | 0.1326 |

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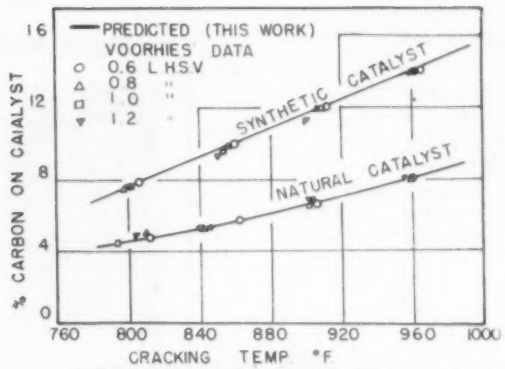


FIGURE 1—Effect of temperature and space velocity on carbon formation.

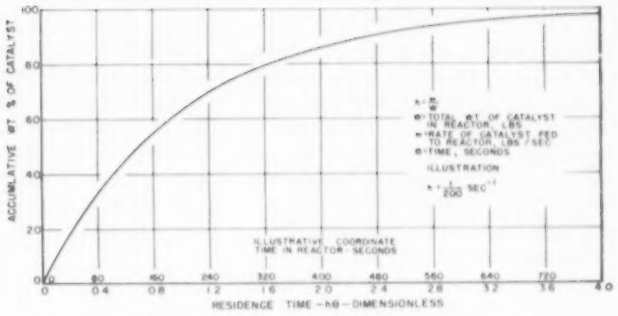


FIGURE 2—Average residence time of catalyst within a turbulent fluidized reactor.

# Carbon Formation in Cat Cracking

**A way to estimate charge rate, process period, and temperature effect on carbon deposited on catalyst.**

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THE EFFECT of charging rate, process period and temperature on the rate of carbon formation on catalyst in fixed reactors can be estimated by equations which have been formulated by the authors.

At the same time methods were developed to apply fixed bed reactor data to estimating of results when using the same charge and catalyst in moving bed or turbulent fluidized reactors. Too, equations were evolved showing the residence of time of catalyst in the moving bed or fluidized reactor.

Such distribution data, it may be noted, furnish the basis for summation of carbon on individual particles of catalyst and thus the average or reported carbon on the catalyst being charged to the regenerator.

The catalytic reactions of petroleum hydrocarbon vapors in the presence of clay masses are heterogeneous, and the rates and products of the reactions are influenced by the nature of the surface and adsorptive power of the catalyst. The action of the adsorbent may be due to physical, relatively weak attractive forces, or it may be due to strong-valent chemical forces; adsorbents of this latter type are characterized by an increase in adsorptive power with a rise in temperature and exhibit high heats of activation. Chemical adsorption is generally considered to precede catalysis, and consequently has the greatest influence on the rate of conversion.[1]

A number of theories have been advanced to predict, qualitatively, the products of the reactions of petroleum vapors in the presence of catalysts. The majority of these are based upon free radical, free ion, or carbonium ion mechanisms,[1,2] and each theory enjoys some measure of success. Few mechanisms have been proposed whereby the products from the catalytic cracking of gas oils may be quantitatively predicted. No doubt this is due to both the complexity of the reacions and the lack of a need for such mechanisms until the last decade. Despite the complexity of the problem, it is possible to develop a relatively simple mechanism capable of quantitative interpretation if the reaction products are considered as being carbon, gasoline and cycle gas oil.

**Mechanism of Carbon Formation in Fixed Bed Units**—When hydrocarbons react in the presence of catalysts at high temperatures a carbonaceous deposit normally accumulates on the catalyst and lowers its activity. This deposit, generally reported as "carbon," may be burned off in a current of air, and in some cases the activity of the catalyst may be restored to near its original value. Thomas reported the formula of this carbonaceous deposit as $(C_2H_4)_n$.[5]

A clearer picture of the phenomena of carbon formation can be obtained if

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the reactants, i. e. the hot petroleum vapors, are envisioned as passing through a fixed bed of freshly regenerated catalyst in a continuous series of waves at a constant temperature. As the first wave of reactants enters the reactor they contact freshly regenerated catalyst with its highest activity. This first wave of molecules continually contacts freshly regenerated catalyst until it passes out the discharge end of the reactor. Now consider a second wave of molecules following the first wave by any time lag "Θ" time units. This second wave represents the general wave, from which it may be considered that any wave of molecules passing through the reactor continually contacts catalyst which has been in the presence of hydrocarbon vapor for the same length of time.

The deduction above indicates that the activity of the catalyst may be constant for any single wave of molecules passing through a fixed bed reactor. However, this cannot be said to be true until additional information is known. This is partially clarified from a study of the reactions in which carbon is formed. If the cracking process were stopped when the first wave of molecules reached the bottom of the reactor, a coke gradient would be expected in proceeding from the top to the bottom of the reactor. In actual practice it has been observed that the amount of carbon does decrease in moving down the bed.

The equation for carbon formation is written assuming that some molecules "$R_n$" react with the catalyst "A" to form a coke deposit. The subscript "n" refers to the number of carbon atoms in molecule "R." The activity of the catalyst is represented by the symbol "A."

$$R_n + A \overset{K}{=} R_nA - R_{n-x} \qquad (1)$$

$R_nA$ is the carbonaceous deposit on the catalyst.
k is the specific rate constant.
A represents the catalyst with activity "A."

From Equation (1) it follows that

$$\frac{d(R_nA)}{d\Theta} = (k)\ (R_n)\ (A) \qquad (2)$$

For convenience let "C" equal the weight percent of carbon on the catalyst, then Equation (2) becomes

$$\frac{dC}{d\Theta} = (k)\ (R_n)\ (A) \qquad (3)$$

According to the mechanism presented herein it is not important that any molecule "$R_n$" reacts to give coke plus some other molecule. Any simple mechanism whereby some molecule "$R_n$" reacts with the catalyst to form coke will lead to the same type equation as (3), that is if:

$$R_n + A \overset{K}{=} R_nA$$

then

$$\frac{d(R_nA)}{d\Theta} = (k)\ (R_n)\ (A) \qquad (4)$$

As the gas oil proceeds through the bed of catalyst, it is converted to an increasing amount of gasoline and cycle gas oil. This gasoline has less tendency to carbonize than the original feed and the cycle gas oil may have a greater tendency to carbonize. To the degree that these two balance each other it might be assumed that the concentration of the substances which react to form carbon is independent of the depth of cracking and therefore of the position in the bed of catalyst. The above thought was originally presented by Voorhies.[6] It should also be pointed out that as the over-all conversion in catalytic cracking is increased the coke deposition also increases.

The influence of charging rate, liquid hourly space velocity (volume of oil charged per volume of catalyst per hour) on the concentration of the carbon producing molecules may be obtained from the general gas law.

$$N = \frac{(P)\ (V)}{(R)\ (T)} \qquad (5)$$

For a given reactor "V" becomes the volume less the volume of solids.

Inspection of the above equation permits the following conclusions: At constant pressure and temperature the concentration or number of moles of vapor in a particular reactor is the same regardless of the liquid space velocity. Evidently then, the amount of carbon on the catalyst should be independent of the charging rate. This is substantiated by actual data shown plotted in Figure 1. Note that the carbon formed is independent of the charging rate.

It is also necessary to know how "A," the "activity" of the catalyst, varies with the carbon deposit. Knowing that for given reaction conditions when "A" is large, the carbon deposit is small, and when "A" is small, the carbon deposit is large, it might be reasonable to expect that the area varies inversely with the carbon deposit. Substituting the inverse ratio, together with Equation (5) into Equation (4) leads to:

$$\frac{dC}{d\Theta} = \frac{(k)\ (P)\ (V)}{(R)\ (T)\ (C)} \qquad (6)$$

or

$$C\,dC = \frac{(k)\ (P)\ (V)\ d\Theta}{(R)\ (T)} \qquad (6a)$$

integrating between the limits

$\Theta = O$, $C = O$ and $\Theta = \Theta$ and $C = C$,

results in

$$C^2 = \frac{2\ (k)\ (P)\ (V)\ (\Theta)}{(R)\ (T)} \qquad (7)$$

For a particular reactor operating at constant pressure, temperature and liquid hourly space velocity, Equation (7) reduces to:

$$C = K\Theta^{1/2} \qquad (8)$$

The validity of Equation (8) has been verified by Voorhies,[6] who found experimentally that a plot of "log C" versus "log Θ" gave a straight line. In actual experiments, the exponent of "Θ" varied from 0.38 to 0.53 for dif-

**Meet the**

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## Authors

WILLIAM A. CUNNINGHAM has been teaching chemical engineering at the University of Texas since 1935. After completing his first two degrees there in 1929, he joined Texas industry, later became associated with the management of the university's mineral-rich lands, and from there was assigned to its Bureau of Industrial Chemistry where he received a research appointment and an opportunity to study for his doctorate. He began instructing chemical engineering classes while still a degree candidate. Dr. Cunningham now is a member of the graduate faculty.

ferent catalysts and charging stocks. This is in very good agreement with the proposed mechanism.

A further check on the validity of this mechanism is afforded by the correlation between temperature and carbon formation. To estimate the carbon formed at one temperature from data obtained at a different temperature, it is necessary to express "k," the specific rate constant, in Equation (7) as a function of temperature. This has been suitably expressed by the Arrhenius equation as [2]

$$k = (B) \exp \frac{-E}{RT} \qquad (9)$$

where,
B is a constant
E is the energy of activation
R is the gas constant
T is the absolute temperature, °K.

Substituting Equation (9) into Equation (7), grouping constants and applying the equation to a reactor of constant volume and pressure leads to:

$$C^2 = \frac{(K)\ (\Theta)}{(T)} \exp \frac{-E}{RT} \qquad (10)$$

Denoting by subscripts the first and second conditions permits the estimation of the carbon formed at one temperature from data obtained at different temperature.

$$\frac{C_1^2}{C_2} = \frac{(T_2)\ (\Theta_1)}{(T_1)\ (\Theta_2)} \exp \frac{(E)}{(R)} \left[\frac{1}{T_2} - \frac{1}{T_1}\right] \qquad (11)$$

An apparent energy of activation has been evaluated from use of the above equation and data shown in Figure 1. According to this mechanism the apparent energy of activation for the deposition of carbon on synthetic catalysts is 16,800 cal./mole. Using natural clay catalysts, the apparent energy of activation is 15,130 cal./mole. These values for the energy of activation for the rupture of the carbon-carbon bond are about one-fourth those reported for the non-catalyzed thermal reaction.[4] A comparison between the actual carbon formed and that estimated from this work is shown in Figure 1. The proximity of the theoretical line to the actual data points is believed to be within the limits of experimental error. It is desired to point out that the energies of activation are not only a function of catalyst type but also the feed stocks.

**Mechanism of Carbon Formation in Moving Catalyst Beds**—It is the purpose of this portion of the paper to show how the data from fixed bed reactors and the equations applying thereto may be utilized so that extrapolation may be made to moving bed reactors without incurring serious errors. It is realized that the moving bed reactors as actually operated in commercial practice do not conform in strict accordance with the assumptions required in the derivation, but they do operate reasonably close. It is believed that the equations will serve effectively in some cases.

From the foregoing discussion on the fixed bed reactors similar analysis will show that the following equations are applicable to the moving bed reactor.

The rate of carbon formation is given by:

$$\frac{dC}{d\Theta} = (k)\ (R_a)\ (A) \qquad (4)$$

where, "Θ" is the time the catalyst is in contact with the hydrocarbon vapors. For the moving bed this is essentially equal to the time the catalyst is in the cracking chamber.

then,

$$\frac{dC}{d\Theta} = \frac{(k)\ (P)\ (V)}{(R)\ (T)\ (C)} \qquad (6)$$

if "C" is zero when "Θ" is zero, integrating gives

$$C^2 = \frac{2(k)\ (P)\ (V)\ (\Theta)}{(R)\ (T)} \qquad (7)$$

if not, then

$$C^2 = \frac{2(k)\ (P)\ (V)\ (\Theta)}{(R)\ (T)} - C_o^2 \qquad (7a)$$

where,
$C_o$ is the weight percent carbon on the catalyst as it is fed to the reactor.

For a particular reactor operating at constant pressure and temperature Equations (7) and (7a) reduce to

$$C = K\Theta^{1/2} \qquad (8)$$

and

$$C = (K\Theta - C_o^2)^{1/2} \qquad (8a)$$

The effect of temperature is obtained by introduction of the Arrhenius equation into Equation (7).

$$C^2 = \frac{(K)}{(T)}(\Theta) \exp \frac{(-E)}{RT} \qquad (10)$$

The carbon formed at one temperature and catalyst rate may be estimated from the carbon formed at other conditions by Equation (11).

$$\left(\frac{C_1}{C_2}\right)^2 = \frac{(T_2)\ (\Theta_1)}{(T_1)\ (\Theta_2)} \exp\left[\frac{E}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)\right] \qquad (11)$$

With aid of actual data, apparent energies of activation may be calculated by Equation (11).

Inspection of Equations (8) and (10) show that the same constants have to be evaluated for the moving bed reactors and fixed bed reactors. These constants are "K" and "E," and could be evaluated in either type of reactor. However, the constants would apply only to the specific catalysts and charge stocks used in their evaluation.

**Mechanism of Carbon Formation in Turbulent Fluidized Beds**—The fluidized catalytic cracking units introduced a new technique as a solution to the catalytic cracking of gas oils. This general principle of continuously admitting and withdrawing materials from a chamber also introduces new complexities into an originally difficult problem, that of estimating the carbon deposited on the catalyst. In such a process fresh materials are being fed into the reactor and a mixture is withdrawn. In a turbulent fluidized reactor, this mixture consists of catalyst particles which have been inside the reactor for different periods of time. A portion of the material withdrawn would have been in the re-

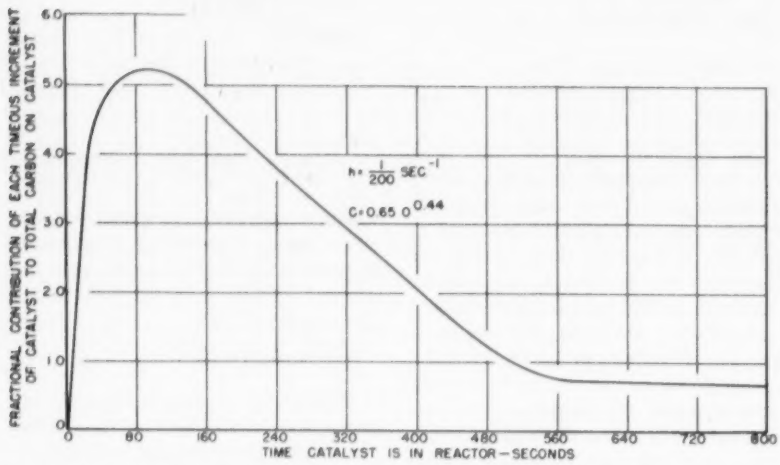


**FIGURE 3—Contribution of each timeous increment of catalyst to total carbon on catalyst.**

actor only a short length of time; while other portions would consist of materials which would have been in the reactor for medium to long periods of time. It is proposed to show how information from fixed bed or moving bed reactors may be utilized so that the data therefrom may be employed for estimating the results when using the same catalyst and charge stock in continuous, turbulent, fluidized reactors.

The mechanism proposed here assumes that the catalyst and hydrocarbon vapor are in a state of high turbulence within the reactor. Catalyst and hydrocarbons are continuously admitted and removed from the reactor, and the catalyst density is constant throughout the reactor. Accordingly, certain particles of catalyst discharged will have been in the reactor only a very short time and a portion of the withdrawn catalyst will have been in the reactor for long periods. The fraction of the catalyst which has been in the reactor less than a given time is given by the following equation:

$$dP = (100 - P)\, h d\theta \qquad (12)$$

where

$$h = \frac{w}{W} \qquad (13)$$

or

$$P = 100 - 100e^{-h\theta} \qquad (14)$$

where

P = the weight percent of catalyst which has been in the reactor less than "θ" time units

w = rate at which the catalyst is charged to the reactor, lbs./sec.

W = total weight of catalyst in the reactor, lbs.

θ = time, seconds

h = reciprocal of time required for an arithmetic turnover of the catalyst; defined by Equation (13). Units are reciprocal seconds.

For the illustration shown here, "h" is assumed equal to 1/200 $sec^{-1}$. This implies that from an arithmetic standpoint a complete turnover of catalyst within the reactor occurs every 200 seconds. According to the laws of probability, a complete turnover of catalyst would never occur but a practical turnover would occur very often.

Equation (14) is a general equation expressing the composition in any well mixed vessel with continuous thruput. For this reason, it is shown plotted in Figure 2 using both the general and specific abscissa. Values of the coordinates are also found in the first three columns of Table 1. From the figure or table it will be noted that 63 percent of the catalyst in the reactor has been there less than 200 seconds or the time for one arithmetic turnover. Approximately 86.5 percent of the catalyst has been in the reactor less than 400 seconds. The percentage of catalyst which has been in the reactor for given times may be obtained by taking the differences in the appropriate readings of Column 3 of Table 1. For example, Column 4 shows that 9.5 percent of the catalyst has been in the reactor from zero to 20 seconds. Approximately 8.5 percent of the catalyst has been in the reactor from 20 to 40 seconds. Only 3.5 percent of the catalyst has been in the reactor 200 to 220 seconds. Figure 3 is a plot of the above and shows the calculated distribution of catalyst within a turbulent fluidized reactor. If the dimensionless lower abscissa is used, the curve is general and may apply to many continuous mixing processes.

Through the use of Figure 3, or preferably the data in Column 4 of the table, is is possible to calculate the carbon on the catalyst in fluidized systems from data obtained in a fixed bed reactor. The equation of carbon formation used here is one which was obtained in a fixed bed reactor using an East Texas charge stock and synthetic cracking catalyst.

The following equation for carbon formation was obtained from a fixed bed reactor:

$$C = 0.65\theta^{0.44} \qquad (15)$$

For the turbulent fluidized reactor Equation (15) becomes:

$$C = 0.65 \sum_{P=0}^{P=100} \Delta P \theta^{0.44} \qquad (16)$$

That is, the total carbon on the catalyst is equal to the sum of the carbon on all particles. The calculations indicated by equation 16 have been carried out and are shown as Columns 5, 6 and 7 of Table 1. Column 5 shows the time in minutes raised to the 0.44 power. Column 6 shows the percent carbon deposited on the catalyst. Note that catalyst which has been in the reactor 20, 200 and 400 seconds will have 0.30, 1.11 and 1.5 percent carbon, respectively. Column 4 shows that only 9.5 percent of the catalyst has been in the reactor zero to 20 seconds, consequently the carbon on these particles will be equal to (0.095) (0.30) = 0.029 weight percent. The product of Column 4 times Column 6 gives the weight percent carbon shown in Column 7. The summation of Column 7 provides the total carbon deposited on the catalyst in the turbulent fluidized reactor. It will be noted that for the conditions cited approximately 1.0 percent carbon will be found on the spent catalyst going to

the regenerator. This is approximately 11 percent less carbon than would be expected if the catalyst were in a fixed bed or moving bed reactor for only 200 seconds. This difference is due to the logarithmic age distribution of the catalyst in the turbulent fluidized reactor.

Figure 4 has been prepared to show the fractional contribution of each timeous increment of catalyst to the total carbon on the catalyst. The data are tabulated in Column 8. From the figure it will be noted that the increments of catalyst which have been in the reactor approximately 80 to 120 seconds possess the largest amount of carbon. Catalyst which has been in the reactor less than this time contributes less of the total carbon because of the small amount of carbon deposited on the catalyst at that time. Catalyst which has been in the reactor longer than 120 seconds contributes less of the total carbon because of the distribution in weight of the catalyst at the longer residence times. It is desired to point out that the use of the arithmetic turnover time will not give an accurate estimate of the carbon on the catalyst.

The effect of temperature on the carbon formed may be determined by introducing the Arrhenius equation into Equation (14). Equation (17) would result. With the aid of actual data such a relation may be used to determine apparent energies of activation:

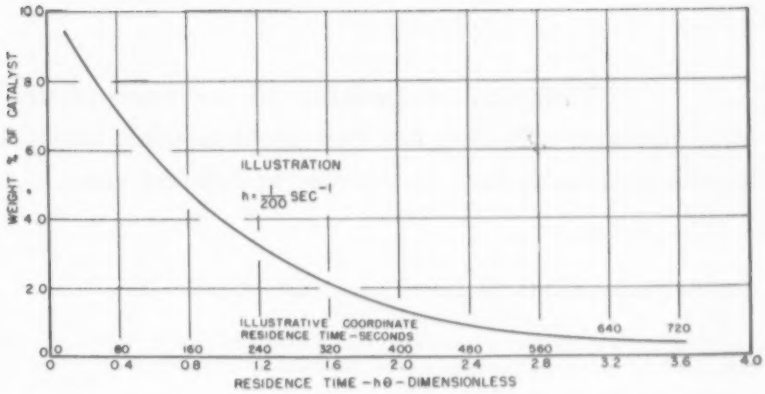


**FIGURE 4—Calculated distribution of catalyst within a turbulent fluidized reactor.**

$$C = Ke^{\frac{-E}{RT}} \sum_{P=0}^{P=100} \Delta P \Theta^{n} \qquad (17)$$


#### ACKNOWLEDGMENT

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**TABLE 1**

**Residence Time and Carbon Formed on Catalysts Within Turbulent Fluidized Beds**

$C = 0.65\Theta^{0.44}$

| Θ Sec. | wΘ/W | P Fraction | ΔP Fraction | $\Theta^{0.44}$ Min. | $0.65\Theta^{0.44}$ Wt. Percent C | $0.65\Delta P\Theta^{0.44}$ Wt. Percent C | $\frac{0.65\Delta P\Theta^{0.44}\times 100}{1.00}$ |
|---|---|---|---|---|---|---|---|
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 percent |
| 20 | 0.1 | 0.095 | 0.095 | 0.62 | 0.30 | 0.029 | 2.9 |
| 40 | 0.2 | 0.180 | 0.085 | 0.84 | 0.55 | 0.047 | 4.7 |
| 60 | 0.3 | 0.259 | 0.079 | 1.00 | 0.65 | 0.051 | 5.1 |
| 80 | 0.4 | 0.329 | 0.070 | 1.13 | 0.74 | 0.052 | 5.2 |
| 100 | 0.5 | 0.393 | 0.064 | 1.25 | 0.81 | 0.052 | 5.2 |
| 120 | 0.6 | 0.452 | 0.059 | 1.36 | 0.88 | 0.052 | 5.2 |
| 140 | 0.7 | 0.503 | 0.051 | 1.45 | 0.94 | 0.048 | 4.8 |
| 160 | 0.8 | 0.551 | 0.048 | 1.54 | 1.00 | 0.048 | 4.8 |
| 180 | 0.9 | 0.594 | 0.043 | 1.62 | 1.05 | 0.045 | 4.5 |
| 200 | 1.0 | 0.632 | 0.038 | 1.70 | 1.11 | 0.042 | 4.2 |
| 220 | 1.1 | 0.667 | 0.035 | 1.77 | 1.15 | 0.040 | 4.0 |
| 240 | 1.2 | 0.698 | 0.032 | 1.84 | 1.20 | 0.038 | 3.8 |
| 260 | 1.3 | 0.727 | 0.029 | 1.91 | 1.24 | 0.036 | 3.6 |
| 280 | 1.4 | 0.754 | 0.027 | 1.97 | 1.28 | 0.035 | 3.5 |
| 300 | 1.5 | 0.777 | 0.023 | 2.03 | 1.32 | 0.030 | 3.0 |
| 320 | 1.6 | 0.798 | 0.022 | 2.09 | 1.36 | 0.030 | 3.0 |
| 340 | 1.7 | 0.817 | 0.019 | 2.15 | 1.40 | 0.026 | 2.6 |
| 360 | 1.9 | 0.834 | 0.017 | 2.20 | 1.43 | 0.025 | 2.5 |
| 380 | 1.9 | 0.851 | 0.017 | 2.25 | 1.46 | 0.025 | 2.5 |
| 400 | 2.0 | 0.865 | 0.014 | 2.30 | 1.50 | 0.021 | 2.1 |
| 500 | 2.5 | 0.918 | 0.053 | 2.52 | 1.64 | 0.082 | 8.2 |
| 600 | 3.0 | 0.950 | 0.022 | 2.75 | 1.79 | 0.039 | 3.9 |
| 800 | 4.0 | 0.985 | 0.035 | 3.12 | 2.03 | 0.071 | 7.1 |
| 1000 | 5.0 | 0.994 | 0.009 | 3.45 | 2.25 | 0.020 | 2.0 |
| | | | | | | 0.984 | |
| | | | | | Limit = | 1.00 | |

#### NOMENCLATURE

- A — represents the activity of the catalyst.
- B — constant in Arrhenius' equation.
- C — weight percent carbon on the catalyst.
- $C_o$ — weight percent carbon on the catalyst as it is fed to the reactor.
- E — energy of activation, cal/mole.
- h — weight of catalyst fed to the reactor per second divided by the weight of catalyst in the reactor, second$^{-1}$.
- k — specific rate constants given by Arrhenius' equation.
- K — constant.
- N — number of moles of gas.
- P — weight percent of catalyst.
- ΔP — weight percent of catalyst remaining in fluidized reactor Δ$\Theta$ units of time.
- R — universal gas constant, liter-atmospheres per degree Kelvin or cal/mol °K.
- $R_a$ — hydrocarbon having "a" carbon atoms per molecule.
- $R_n$ — hydrocarbon having "n" carbon atoms per molecule.
- $R_a \times A$ — carbonaceous deposit adhering to catalyst.
- T — temperature, °K.
- V — volume of one mole of gas at operating conditions, liters.
- w — pounds of catalyst charged to fluidized reactor per second.
- W — total weight of catalyst in fluidized reactor, lbs.
- x — magnitude of a single observed quantity, for illustration, unit is seconds.
- y — frequency of occurrence, fractional.
- $\Theta$ — time catalyst is in reactor, minutes. Where 'h$\Theta$' appears time is in seconds.

# Compressor Cylinders Without Cooling?

**Two years experience in operating plants without the use of jacket water in compressor cylinders has convinced Sinclair that there is no measurable loss in gas handling capacity and no increase in cylinder wear.**

**J. L. Gallagher and H. W. Evans,** Sinclair Oil & Gas Company, Tulsa

About three years ago Sinclair Oil and Gas Company made a study of ways and means of reducing operating and maintenance expense. Having operated compressor cylinders without cooling water during repair periods, it was decided to run tests to determine the effects of this operation. Jacket water was cut off and drained on one cylinder each of first, second and third stages at one plant. Before operating without water, all the parts were inspected and measured for wear. The cylinders were then operated for 30 days and again inspected and measured. No measurable wear was found. The test was continued for an additional 60 days and again on careful inspection no measurable wear was found. Tests were then started at the various other plants and the results were the same for every test. After approximately one year of testing, the plan was adopted at other plants, and the cooling water was shut off from all compressor cylinders.

This experience prompted a study of the theory of compressor cooling.

**Compressor Theory.** The removal of the heat of compression from a compressor cylinder is an important factor in compressor efficiency. When all the heat of compression is removed we have *isothermal* compression. If none of the heat of compression is removed, we have *adiabatic* compression.

The design of practical compressor cylinders is such that even though water is circulated in the jackets only a nominal amount of heat can be removed and the actual cylinder performance is not far from adiabatic compression. Since in actual practice some, but not all of the heat is removed, this performance would fall in the classification of *polytropic* compression.

**Power Requirement.** For the purpose of comparing the horsepower requirements of adiabatic and polytropic compression, assume that by circulating cooling water, temperature of the discharge gas is reduced by 20° F. The assumed temperature reduction is intended to be more than will likely occur in practice. This assumption is made high to be sure that the horsepower difference calculated will be as great or greater than any actual instance.

Air is chosen as the gas to be studied because compressed-air data are universally accepted and the horsepower calculated will be a maximum for a given set of conditions. Compare the theoretic adiabatic and polytropic horsepower required to compress 1 million cubic feet of air through four compression ratios. The adiabatic compression ($n = 1.4$) requires 75.2 horsepower and the polytropic compression ($n = 1.365$) requires 74.2 horsepower. This means that the gross benefit of circulating jacket water could not be more than 1 horsepower per million cubic feet of air compressed.

On the other hand, some horsepower must be used to circulate jacket water. If a 500 Btu per horsepower heat rejection from the cylinder is assumed, as recommended by a prominent compressor manufacturer and a 5-degree temperature rise in the cooling water, then more than 0.25 horsepower will be required for pumping the compressor jacket water.

In connection with the comparison of horsepower required, it should be remembered that operators who use closed system cooling generally use the same pumps for circulating water for cooling both the compressor and the engine. This means that high-temperature water will be pumped to the compressor cylinders. This water will heat the incoming gas and so increase the horsepower required to compress a given weight of gas. Thus, it is seen that the horsepower required to circulate jacket water and the additional horsepower required due to heating incoming gas have reduced the very small 1-horsepower gain from the use of jacket water until it can be safely said that the horsepower requirements will be decreased less than 1 percent by circulating jacket water.

**Capacity. The maximum gas-handling capacity of a specific cylinder will be increased approximately 0.25 percent by not circulating jacket water. We may safely expect this increase in gas-handling capacity since at the higher temperature the clearance volume will contain less weight of gas at the end of the stroke. The actual amount of increase will depend on the amount of clearance volume and the absolute temperature of the gas remaining at the end of the stroke.**

**Heat-Transfer Theory.** The data in Table 1 are not as extensive as might be desired, however, they do suggest some very interesting studies. It will be noticed that in test No. 1 the temperature of the compressor discharge is actually higher when circulating jacket water than it is when no water is circulated.

A detailed study of heat transfer through the cylinder walls will help explain this phenomenon. This reversal of expected temperatures occurs only where jacket water temperature is relatively high. Figure 1 is a schematic picture of temperature differences through a hypothetical cylin-

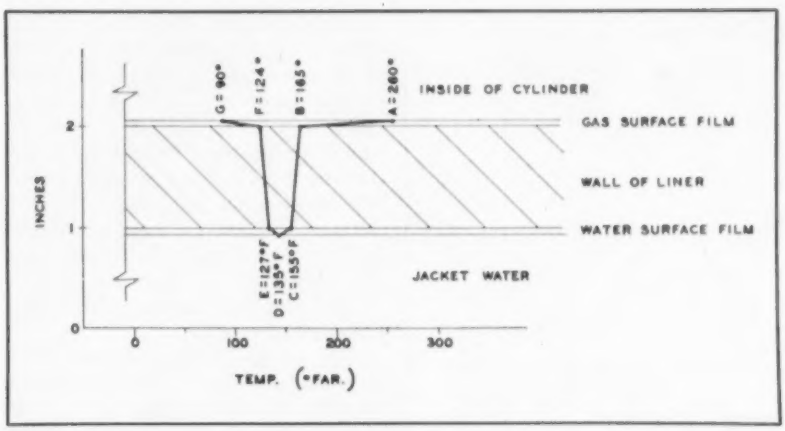



**FIGURE 1—Schematic of temperature differences through a hypothetical cylinder wall at the beginning and end of the stroke.**

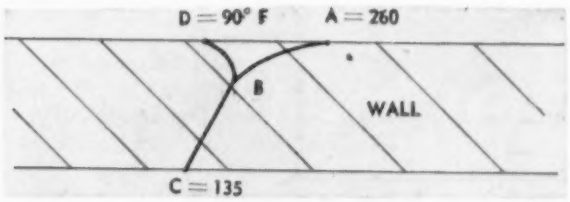



**FIGURE 2—Schematic of temperature fluctuation as expected in compressor cylinder wall. This fluctuation penetrates about 1° F. at approximately ⅜-inch.**

der wall at the beginning and at the end of the stroke. Points *A, B, C,* and *D* represent temperature as heat travels from the gas in the cylinder to the jacket water at the end of the stroke. Points *D, E, F,* and *G* represent temperatures as heat travels from the jacket water to the gas at the beginning of the stroke. The temperatures shown on Figure 1 as the heat flows from the gas to the jacket water are calculated for a flow of 15,300 Btu per hour, or a 20-degree reduction in discharge temperature of 1 Mmcf of air. The heat flow from jacket water to gas was calculated on the basis of temperatures of water and gas shown, and the surface temperatures were calculated from this rate of flow.

It can be seen from Figure 1 that the jacket water would not have to go much higher before the direction of the heat flow is reversed and more heat would travel from the jacket water to the gas at the beginning of the stroke than is returned from the gas to the jacket water at the end of the stroke. Our calculations indicate that with 150° F. cooling water to the hypothetical cylinder, more heat will be transferred from the water to the gas during the suction stroke than from the gas to the water during the compression and discharge portions of the stroke. The tabulated data shows that this actually has accurred. It is also true that as the n-value decreases the temperature at which the reversal of heat flow occurs, will be lower. This situation requires some small additional horsepower to compress the gas.

Figure 1 is treated as if the conditions at the beginning and the end of the stroke existed separately and were of the nature of steady flow to better emphasize the heat flow in each direction. Actually the outside wall of the cylinder liner remains at some constant temperature while the inside temperature of the liner will fluctuate with the temperature of the gas being compressed.

Dr. V. L. Maleeve states that in the internal-combustion-engine cylinder wall the temperature fluctuation does not penetrate deeply. The range of fluctuation is only 1° F. at approximately ⅜ inch from the inside surface of the cylinder. Figure 2 is a schematic picture of this type temperature fluctuation as it is expected to occur in the compressor cylinder wall. This conception of heat transfer helps to strengthen our belief that the conventional compressor cylinder is a very poor heat exchanger.

**Quantity of Heat Transferred.** The study of the quantity of heat transferred is begun by referring to Figure 3, which is a schematic drawing showing the relationship of stroke to temperatures inside the head end of a compressor cylinder during one complete revolution of the crankshaft. The frame end diagram is omitted to simplify the drawing.

To prepare the data for Figure 3, the performance of a 15.1-inch by 14-inch compressor cylinder operating at 300 rpm with 10 percent of clearance and a compression ratio of 4 is used. This hypothetical cylinder is used because it will compress 1 Mmcf of air from 14.7 psia to 58.8 psia. The calculated quantity of heat transferred through the wall of this cylinder to 90° F. cooling water will be compared with the amount of heat considered to be removed by the cooling water in an earlier example. Referring to Figure 3, air is compressed along line *AB*. This compression increases the air temperatures from 90° to 355° F. To accomplish this compression the piston must move through 9.7 inches of its 14-inch forward stroke. This 9.7-inch of piston travel requires 31 percent of the time for one complete revolution of the crank, and during this time 0.192 Btu is transferred to the cooling water.

The 335° F. air is then discharged along line *BC*. The piston travel is 4.3-inches and requires 19 percent of the time for one revolution. During the discharge portion of the stroke 0.083 Btu is transferred to the jacket water.

Air remaining in the clearance volume is next expanded from *C* to *D* and the temperature is reduced from 335° to 90° F. Expansion occurs through 2.4-inches of piston travel and requires 15 percent of the time of one revolution. During expansion 0.022 Btu is transferred to the jacket water.

Intake occurs from *D* to *A* through 11.6-inches of piston travel, which requires 35 percent of the time required for one complete revolution of the crank. Since the jacket water and the gas are the same temperature in this example, no heat is transferred during the suction stroke. Thus for one complete revolution it is calcu-

## Compressor Cylinder Without Cooling? . . .

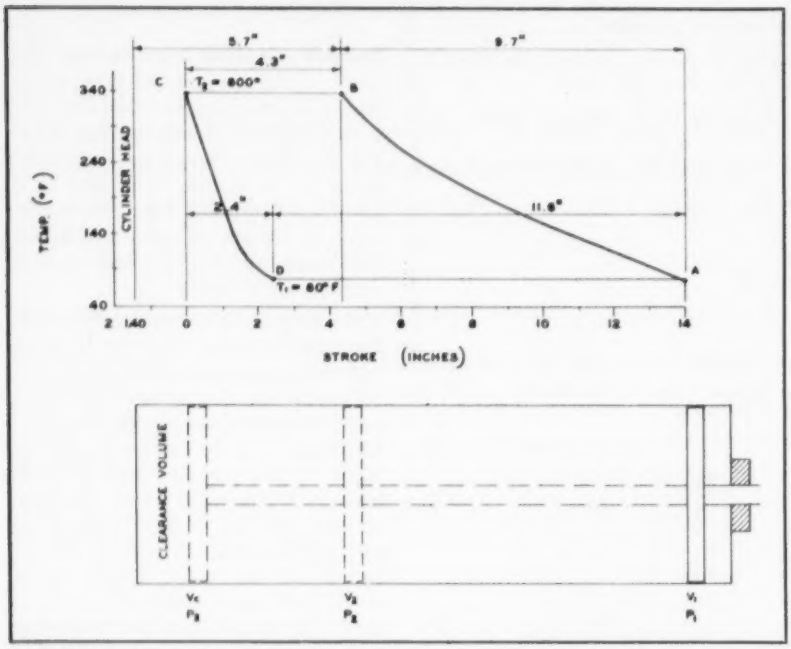



**FIGURE 3—Schematic showing relation of stroke to temperatures inside the head end of a compressor cylinder.**

lated that 0.279 Btu is transferred through the cylinder walls to the jacket water, from the head end, which is a total of 10,000 Btu per hour. This 10,000 Btu per hour is a great deal less than the conventional figure of 57,500 Btu per hour recommended by engine manufacturers and is considerably less than 15,400 Btu per hour which must be removed by the jacket water if the compressor discharge temperature is to be reduced 20° F. The point is that we are spending time and money installing cooling equipment that is not necessary for efficient compressor operation.

**Practical Application.** No complicated procedure is required to prepare a plant for operating without cooling water in the compressor jackets. The cooling water is simply shut off, the piping taken out, and the pipe connections covered with screen wire. Filling of the water jackets with oil has been tried, but no definite advantage has been noted. This troublesome procedure has been discontinued. It requires unnecessary time and expense for installation and maintenance. It seems reasonable to expect that the temperature difference between the cylinder liner and piston will be smaller when no cooling water is present.

Experience has been that any compressor cylinder operating satisfactorily with jacket water will do an equally good job without jacket water. Compressor cylinders have been operated without cooling water to as high as 6.5 compression ratios without encountering trouble. It is not possible to say what is the practical upper limit of compression ratio. It should be pointed out that discharge temperature as high as 550° F. has been considered.

This temperature occurred in a station where gas was to be compressed from 26 inches Hg vacuum to 50 psig through three stages without intercooling and compressor jacket water cooling. The difficulty anticipated was in the case where a field line became parted and the gas to the compressor suction changed to air. This high percentage of air in the compressor increased the value *n* and as a result of the increase in *n-value*, the discharge temperature of the gas was increased until it was alarmingly near the combustion temperature of the lube oil and heavy components in the gas. To avoid this high temperature, an intercooler was installed between second and third stages, reducing the danger of explosion.

The operation of compressor cylinders without jacket water has been found to be very helpful, especially in those cases where the engine jackets are cooled by ebullition. The 212° F. or higher water being circulated for the engine jacket is out of the question as a coolant for compressor cylinders. The conventional practice is to install an extra cooling coil to supply colder water for the compressor cylinders. The simplification of the cooling system by omitting the extra cooling coil pump and piping is especially attractive in these cases.

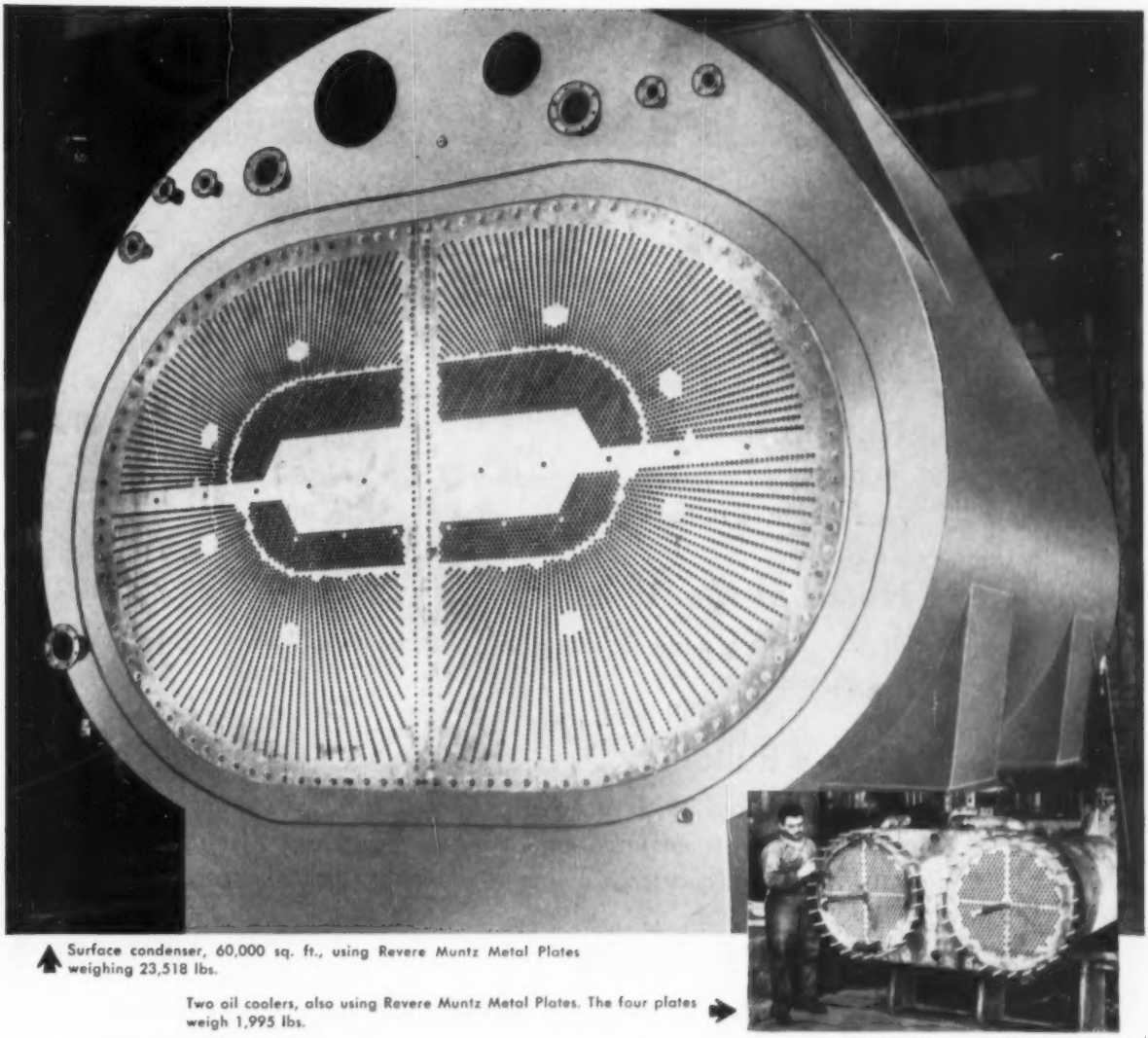
**Conclusion.** Two years of experience operating plants without the use of jacket water in the cylinders has prompted the belief that there is no measurable loss in gashandling capacity and no increase in cylinder wear.

The use of cooling water on gas compressor cylinders on all new installations have been discontinued by the company, thereby saving installation cost of pumps, headers, and compressor cylinder water piping. Also water usage has been reduced, as have treating costs and operating and maintenance expense.

This article was abstracted from a paper presented at the ASME meeting, New Orleans, Sept. 25-28, 1955. ##

**TABLE 1**

| Cylinder Size | Stage | Jacket Water Temp. °F. In | Jacket Water Temp. °F. Out | SUCTION Psig. or " Hg. | SUCTION Temp. °F. | DISCHARGE " Hg. or Psig. | DISCHARGE Temp. °F. | T | R | N |
|---|---|---|---|---|---|---|---|---|---|---|
| **TEST NUMBER 1** | | | | | | | | | | |
| 18 x 20 | 1st | 135 | 140 | 11.2" | 78 | 36 | 266 | 188 | 5.61 | 1.21 |
| 18 x 20 | 1st | None | None | 11.2 | 78 | 36 | 264 | 186 | 5.61 | 1.207 |
| 8¼ x 20 | 2nd | 135 | 140 | 31 | 110 | 275 | 298 | 188 | 6.36 | 1.184 |
| 8½ x 20 | 2nd | None | None | 31 | 100 | 270 | 283 | 183 | 6.25 | 1.184 |
| **TEST NUMBER 2** | | | | | | | | | | |
| 33 x 20 | 1st | 85 | 94 | 19" | 60 | 5" | 168 | 108 | 2.33 | 1.292 |
| 33 x 20 | 1st | None | None | 18" | 78 | 3 | 189 | 111 | 2.3 | 1.288 |
| 19 x 20 | 2nd | 85 | 94 | 5" | 147 | 45 | 282 | 135 | 5.0 | 1.142 |
| 19 x 20 | 2nd | None | None | 3" | 164 | 49 | 341 | 177 | 4.92 | 1.184 |
| 10 x 20 | 3rd | 85 | 100 | 42 | 97 | 260 | 248 | 151 | 4.87 | 1.178 |
| 10 x 20 | 3rd | None | None | 44 | 99 | 252 | 267 | 168 | 4.56 | 1.209 |



▲ Surface condenser, 60,000 sq. ft., using Revere Muntz Metal Plates weighing 23,518 lbs.

Two oil coolers, also using Revere Muntz Metal Plates. The four plates weigh 1,995 lbs. ➔

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Revere supplies condenser and heat exchanger plates and tubes in all the usual alloys, including not only Muntz Metal, but Admiralty Metal, Aluminum, Bronze and Brass, and Cupro-Nickel. The latter is especially advisable for difficult water conditions, such as salt, brackish or heavily contaminated water. Selection of the correct alloy to meet actual operating conditions may at times be a problem. Consult Revere. We will be glad to collaborate on such matters, and recommend the alloy most likely to serve long and economically. See the nearest Revere Sales Office.

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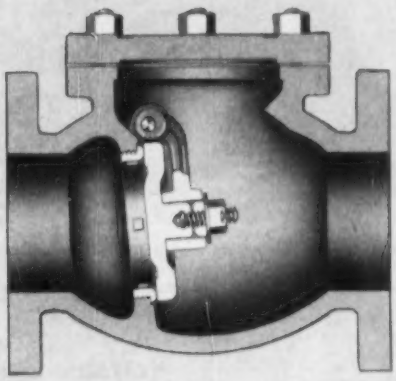
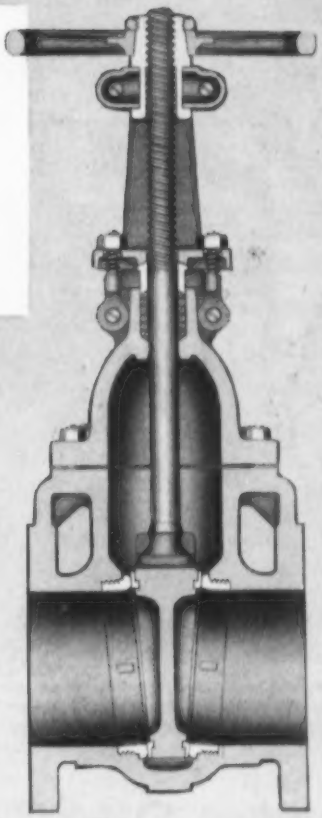


Cross section, Check, No. 14493
Flanged ends



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These valves have an outstanding record in the pulp and paper industry in handling various alkaline liquors. In wood treating they're used successfully on creosote vapors and oils. They're ideal, in the petroleum industry, for handling oils containing traces of mineral acids.

Crane 18-8 SMo alloy trim in these valves combines with nickel alloy body to assure tight seating and smooth, maintenance-free operation. The gates have Crane features such as: full-length disc guides . . . 2-piece ball-type gland . . . T-head disc-stem connection.

The checks feature all 18-8 SMo trim, including body ring, disc, hinge and hinge pin in sizes 2 to 12 inches. Valves 14 inches and larger have disc same as body, with 18-8 SMo disc faces.

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# How To Do It . . .

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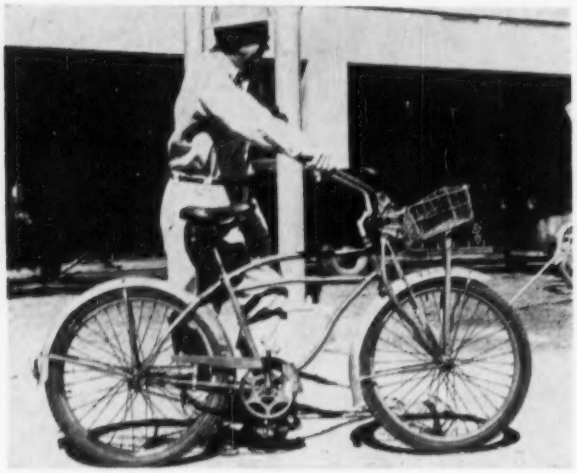

Hot dip galvanize bicycles used for refinery messenger service and eliminate the yearly dismantling and repairing chore required by year-round exposure to the elements. Galvanized coat lasts the life of the bicycle.

New motor scooters used for refinery transportation can feature all-sheet-metal parts made of galvanized steel. Experience indicates that these parts will stand up indefinitely.

## Try Hot-Dip Galvanizing To Cut Maintenance Costs

Hot dip galvanizing has solved an expensive maintenance problem. One company owns and maintains about 500 bicycles for transportation and messenger service within its refinery.

These bicycles are left outside at all times in a high humidity atmosphere where annual rainfall averages 50 inches.

It was found that the bicycles could be galvanized after dismantling at a cost somewhat less than for repainting. The galvanizing eliminates the painting problem for the life of the bicycle, cuts down time to a minimum.

This application of galvanizing has been so successful that new motor scooters now being ordered for refinery use are being supplied with all sheet metal parts already galvanized.

In both cases, galvanizing also is an ideal solution to the paint-damage problem resulting from rough use and handling.

## Portable Generator Useful In Outdoor Maintenance

For emergency lighting and as a light source for outdoor maintenance work in non-hazardous areas, use a portable generator equipped with flood-lights and receptacles.

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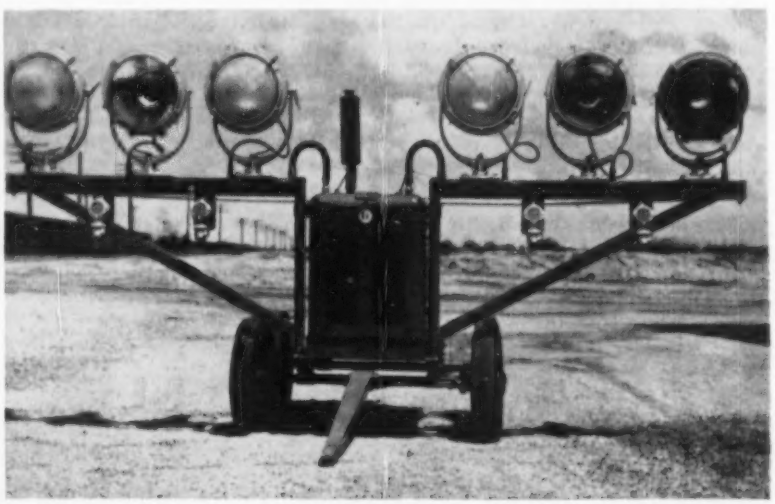

# What it takes to make a 3000 Degree Refractory Concrete

Because of the widespread interest in the use of refractory castables, many furnace operators have asked us for the story behind the performance of B&W's unique refractory concrete, Kaocast.

**Here are the answers to some of the most frequently asked questions:**

**Q.** *When you refer to Kaocast as a 3000 degree refractory castable, do you mean that its melting point is 3000° F?*

**A.** No, this means that its service use limit is 3000° F; its melting point is 200 degrees higher.

**Q.** *Just what does it take to make a 3000 degree refractory castable like B&W Kaocast?*

**A.** Let's first define a few terms. Refractory castables are made with granular materials which are volume stable at high temperatures and which can undergo repeated heating and cooling cycles without disintegration. These materials, known as refractory calcines or grogs, are blended with suitable hydraulic binders. The initial strength of a refractory castable is thus developed in the same manner as that of ordinary concrete—that is, through the chemical action between water and the binder. A strong *ceramic bond* is formed when the refractory castable is subjected to temperatures above the vitrification point.

**Q.** *Then you have a grog, a binder and a method of putting them together. Which is most important?*

**A.** You can't say that any *one* is most important. It's a combination of all three. Let's take them one at a time. Our grog consists primarily of the proper blend of kaolin and other alumina-silica materials. This ratio enables us to achieve a grog with minimum expansion and shrinkage, a high fusion point, and greater stability under load, at varying temperatures.

**Q.** *And now, what about the binder?*

**A.** There are a number of factors responsible for the success of the Kaocast binder. One is the compound Tricalcium Penta-aluminate (3 lime to 5 alumina). This formula produces the most refractory compound (highest melting point) that can be made from lime and alumina. Another is that by using the purest commercially available lime and alumina, the Kaocast binder is substantially free of iron and silica. Such traces of these that are present combine during the pre-firing of the binder to produce stable compounds.

**Q.** *Just how important is the manufacturing or "blending" of the grog and the binder?*

**A.** If one factor could be singled out as "most important" it would be quality control.

Direct control over the fineness of materials, prefiring temperatures, and other phases of manufacture is possible at B&W because both the grog and the binder are made and blended at B&W's Augusta Works—under B&W's direct control and supervision.

**Q.** *These factors you've discussed must add up to some specific advantages of Kaocast. What are they?*

**A.** B&W Kaocast has all the advantages of easy installation which are responsible for the widespread interest in refractory concretes, plus these exclusive features: It is the only 3000 degree refractory concrete with high resistance to spalling and low volume change throughout its operating range.

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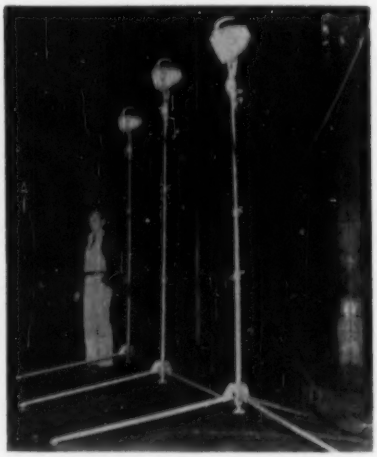
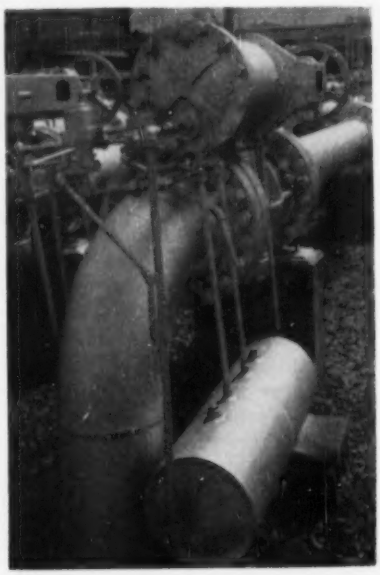


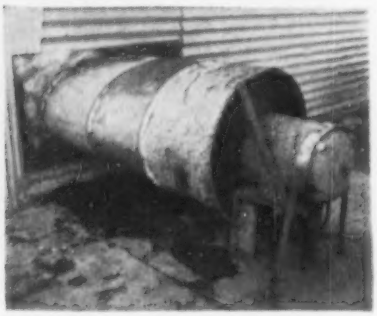


### Air-Hydraulic Convert Will Ease Operations

A problem often arises where remote-controlled valves operate by hydraulic pressure with the plant set up on air or gas controls. The valves are hard to adjust to keep them from closing or opening too rapidly when air is used in place of an hydraulic fluid.

One company overcame this difficulty by placing a pot near and below the valve and filling it with hydraulic fluid. The outlet to the valve is on the bottom; the air control is tied into the top. When the air is turned on, the hydraulic fluid is forced out the bottom to operate the valve. As soon as the air pressure is turned off, the oil will drain into the vessel and allow the valve to close.

Shown is a hookup where two valves are operated from the same vessel with a blank wall between so that the compartments actually operate as separate vessels.



### Old Drums Can be Used To Build an Exhaust

Where it is necessary to use forced ventilation to remove fumes, a simple duct may be made by welding together several used oil drums and installing a fan on the end. The fan can be made from a standard electric motor, with a purchased fan blade attached to the shaft in place of a pulley.

In the example shown, the duct leads to the welding bench. The welding is done on a grate across the top of the ducts, so that fumes from the torch are drawn directly to the outside of the building. The motor support is set in concrete so it will not vibrate and make noise.

### Make Pipe Rack for Truck

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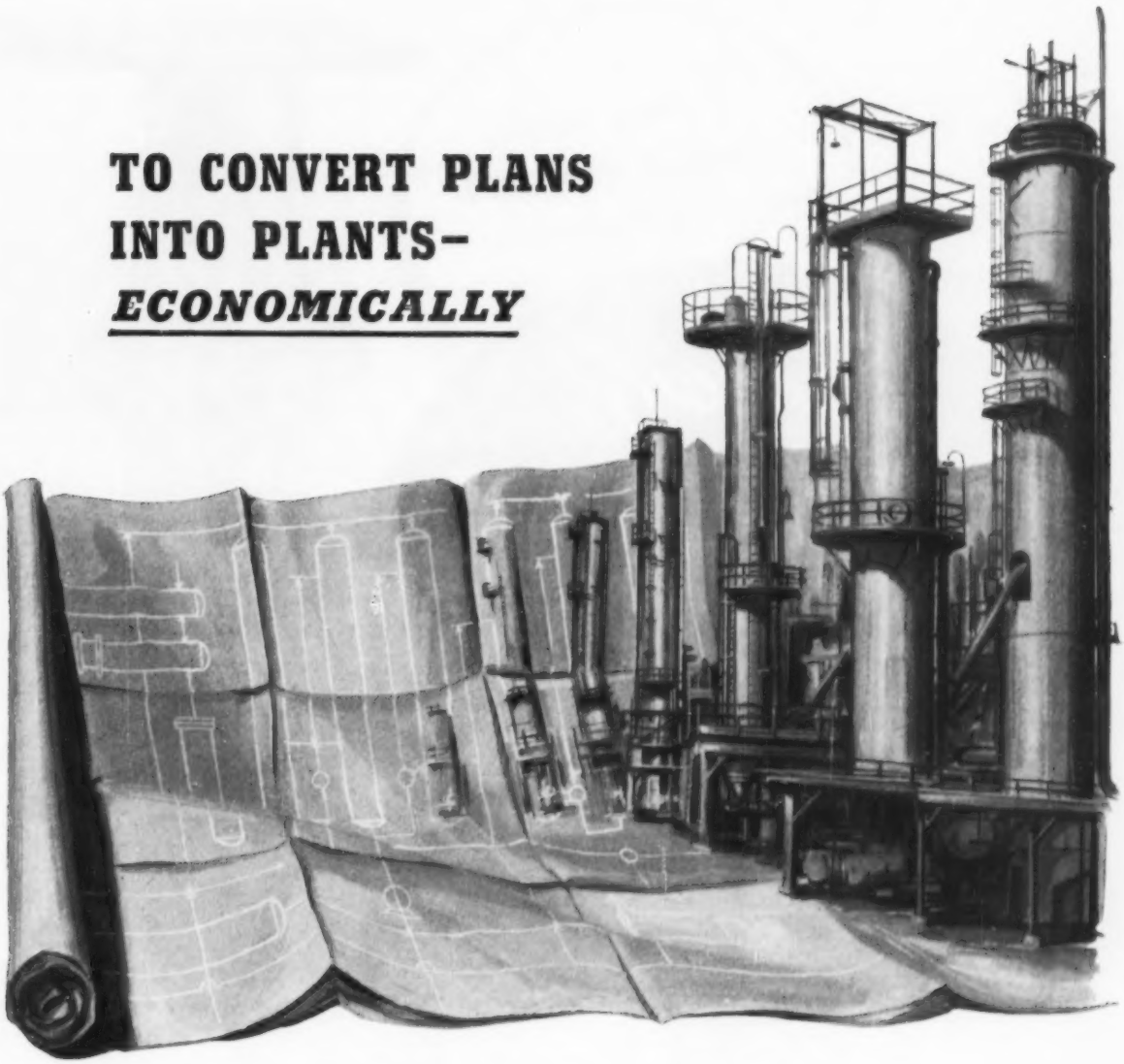

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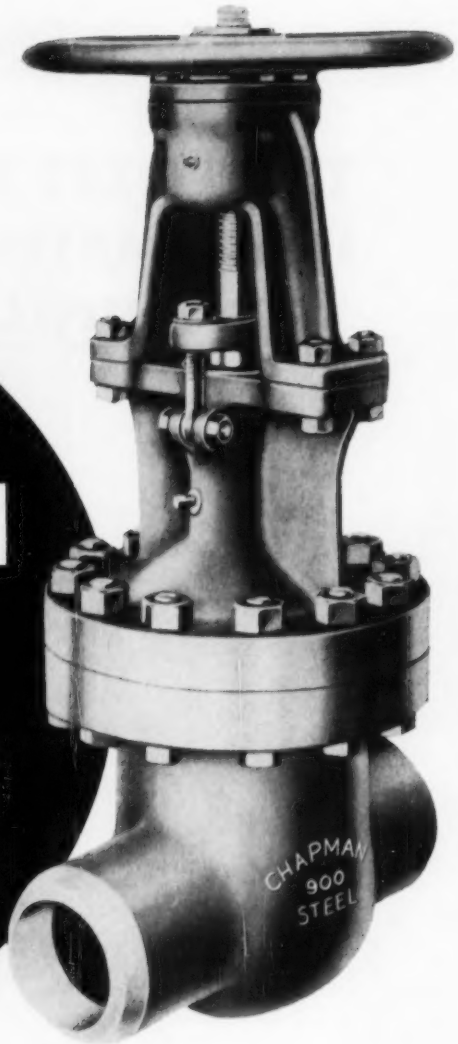


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work is of one-inch pipe with the exception of the peaked roof, which is of ¾-inch pipe.

### Stand for Safety Gear Can be Made in Shop

Where fire and safety devices are mounted on wheels, it is best to have them off the ground. This prevents corrosion, and the unit is readily accessible in case it is needed.

One company made a stand to hold the equipment. It has an inclined ramp on the front so that the equipment could be wheeled down easily. A prop hinged to the front of the stand keeps the unit upright.

The stand is made from three pieces of 2-inch pipe about 6-feet long. One piece is split down the middle and used to make the runners for the wheels. The risers are welded to the two lower pieces to provide a firm support. Cross members at the back lower corner and the front, where the hinge is welded, make the unit solid.

**Send your How-to-Do-It ideas with photos to Editor, Petroleum Refiner, P. O. Box 2608, Houston, Texas.**


How can I reduce tube cleaning down-time ?

...with AIRETOOL tube cleaners!

**SUBTRACT costly downtime**

Coke and clogged tubes eat a big hole in a cost control sheet. It's natural then, that more and more refineries are coming to rely on the realistic savings Airetool tube maintenance equipment adds.

Take the Airetool "6000" series of cleaners for example. In matter of minutes (not hours), they whisk away profit-stealing deposits from tubes that slow up your production.

Airetool ball-bearing motor with single expansion cutter head for cleaning straight tubes. Motor is slip-fit constructed, and has front and rear ball-bearing thrusts.

**MULTIPLY precious profit**

Reliable reports from many make this a fact.

Maybe you want to subtract some of that costly downtime from your tube maintenance jobs — by adding the advantages of Airetool.

We'd be happy to prove our point on the toughest tube assignment you can come up with. Write us direct — or if you prefer — call in the Airetool representative nearest you.

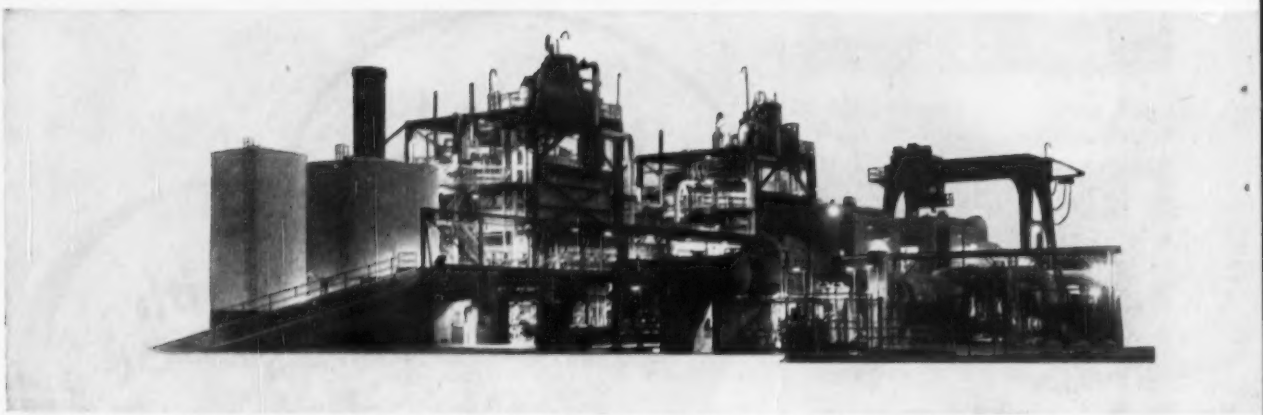
*"There's an Airetool Tube Cleaner and Tube Expander for Every Type of Tubular Construction."*

**AIRETOOL**
MANUFACTURING COMPANY
SPRINGFIELD, OHIO

**BRANCH OFFICES:** New York, Chicago, Philadelphia, Houston, Tulsa, Baton Rouge. Representatives in principal cities of U.S.A., Canada, Mexico, South America, England, Puerto Rico, Hawaii, Japan, Italy
**EUROPEAN PLANT:** Airetool Nederland N.V., Vlaardingen, The Netherlands



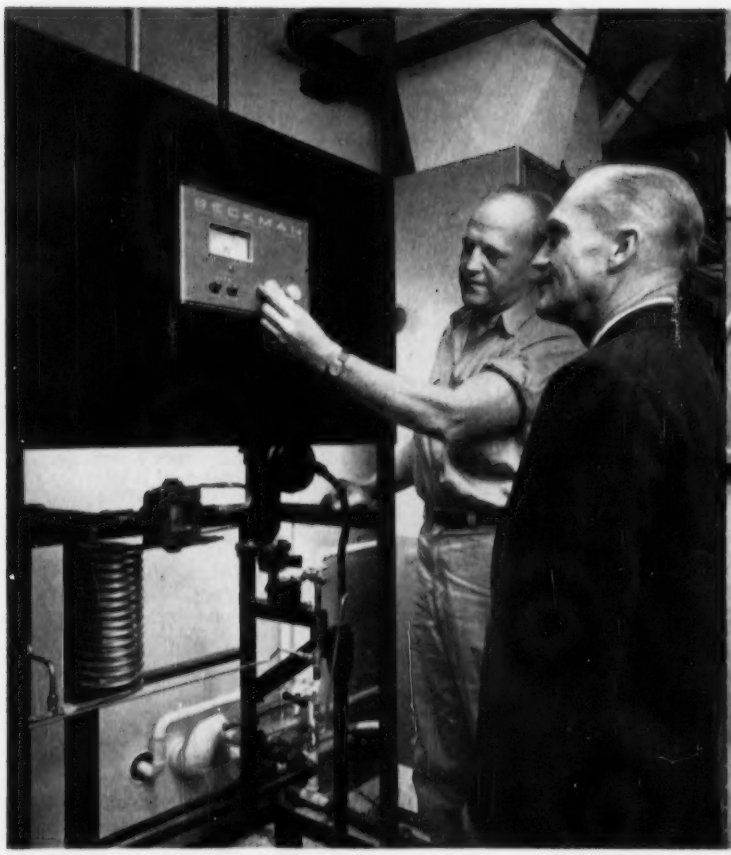

For more data on advertised products, use Readers' Service Cards, last page.



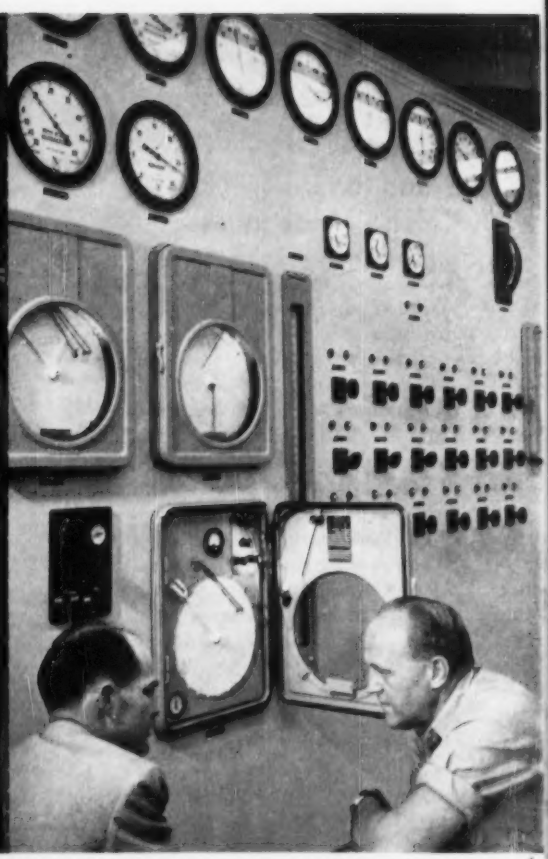
California Electric Power Company's 140,000 KW steam generating plant at Highgrove in Southern California.

*problem:* **13 POWER SHUTDOWNS IN ONE YEAR**

*solution:* **BECKMAN pH MEASUREMENT AND CONTROL**




Precise pH measurement and control means trouble-free operation at Highgrove.



The pH of both make-up water and cooling water is recorded simultaneously on a single recorder.

*Free Engineering Service—by mail*

A specially prepared System Analysis Form is available to help you isolate your continuous pH measurement problems. When form is returned to us with necessary data, Beckman engineers will mail you a written report suggesting suitable solutions, without cost or obligation on your part.

*Beckman Division*
**BECKMAN INSTRUMENTS, INC.**
*Fullerton 1, California*

☐ Please send me a pH System Analysis Form that will entitle me to a free engineering analysis and recommendation for solving pH problems at our plant.

☐ Please send me a copy of "Industrial pH Measurement and Control" and add my name to your mailing list to receive additional information on pH control.

*Name:*_____ *Title:*_____

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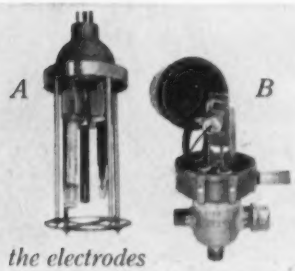
2-25

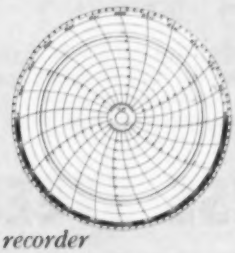
*This coupon will bring you important information on pH.*

Accuracy and reliability of Beckman pH measurement and control were major factors in overcoming a series of costly shutdowns during the first two years of operation at the California Electric Power Company's new steam-electric power plant at Highgrove, California. Beckman electrodes and pH meters were included as key instrumentation in the cooling water circulating system for the plant's first two units.




*1. the electrodes*

*2. the pH meter*



*3. the recorder*

*Beckman pH equipment is also sold through recorder-controller companies.*

Daily permanent records of wide variations in pH helped solve a troublesome water treatment problem which caused 13 shutdowns in one year.

Condenser efficiency dropped, generating capacity was curtailed, main cooling water pipes had to be lined and maintenance costs skyrocketed.

**Cooling water causes damage**

A portion of the plant's cooling water comes from an irrigation canal carrying effluent from the city of Colton to the north. This water contains detergents in solution. A thin calcium phosphate film formed on condenser tubes, causing a marked loss in efficiency. Back pressure was a serious problem. Condensers had to be shut down and cleaned 13 times during one year with resulting loss in generating capacity. The 72-inch steel water pipelines from cooling towers to condensers corroded and were centerlined with cement.

**pH control is plant protection**

Complete, accurate and permanent records of pH trends in cooling water helped Highgrove personnel revise water treatment procedure and obtain more precise addition of chemicals for pH control. Eight months later condensers were opened for inspection and required absolutely no maintenance. Back pressure problem had disappeared. Pipe corrosion and deterioration of wooden cooling towers was arrested. One year later none of the units had been shut down once because of cooling water problems.

When units 3 and 4 were built, Beckman industrial pH instrumentation was again specified, this time incorporating fully automatic addition of chemicals to maintain cooling water at the desired 7.3 to 7.6 pH range.

**Make-up water also controlled**

Beckman pH electrodes and meters also keep a constant check on boiler make-up water which is held between 8.8 and 9.0 pH to prevent corrosion in the wet stages of the turbine and condensate systems. With this precise and unvarying pH control, condensate systems are virtually free of any trace of corrosion. Beckman electrodes are cleaned and buffered just once a month. Accuracy is within .2 pH unit and could be maintained closer if necessary. Electrical interference from generators is negligible.

**BECKMAN INDUSTRIAL pH CONTROL**

Throughout industry, Beckman continuous automatic pH measurement and control systems are increasing the operating life of equipment, lowering maintenance costs, insuring the quality of products, and providing permanent records of efficient operation. It consists of three simple elements:

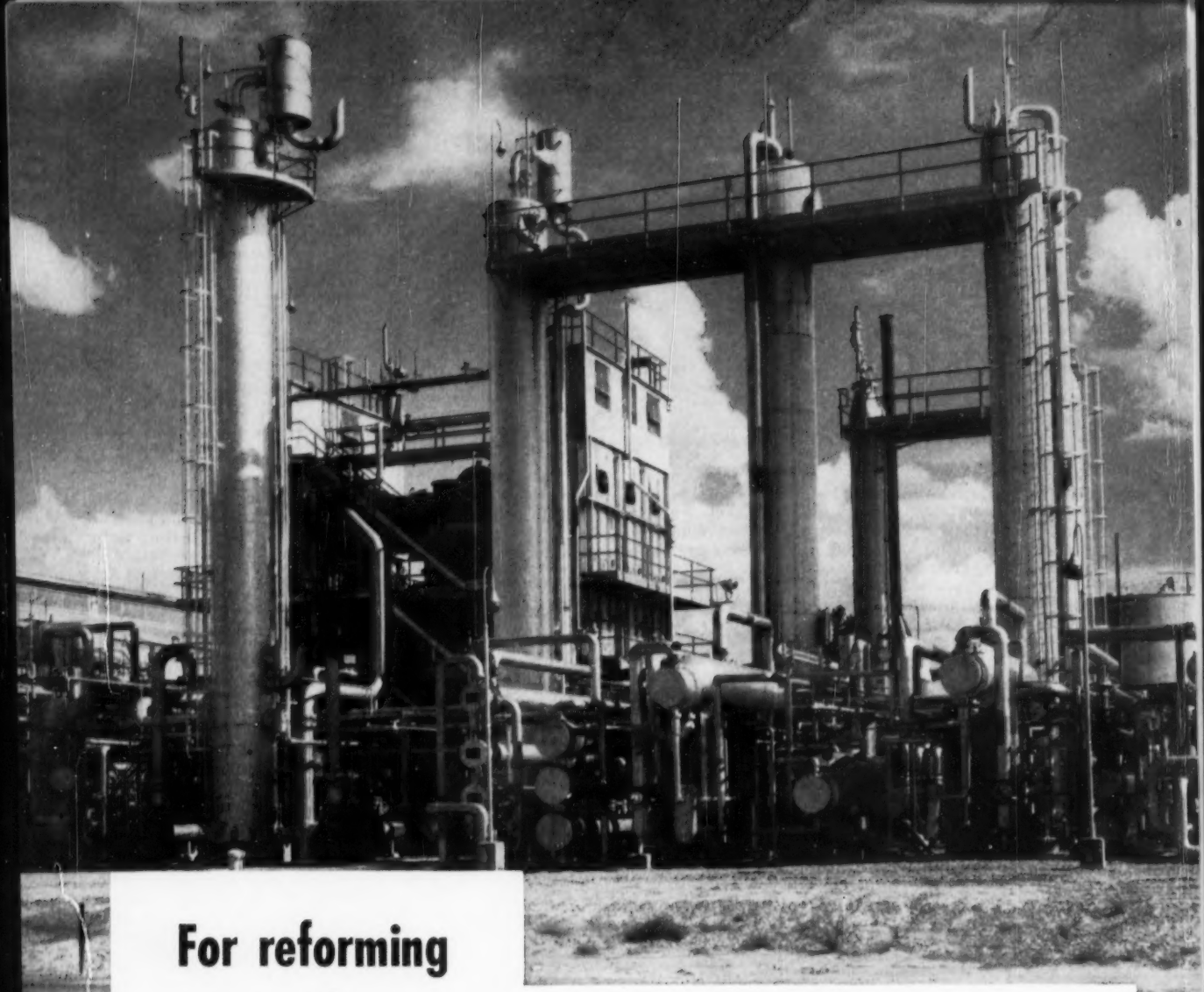
**1. The Electrodes** Beckman glass electrodes are almost unbreakable and require very little care. They may be mounted in immersion (A) or flow (B) assemblies.

**2. The pH Meter** Beckman pH meters are famous around the world. Sturdy, accurate and dependable, they amplify the small voltage from the electrodes and translate it into pH units. One meter can monitor (manually or automatically) six different points in process systems, giving either simple meter indications or automatic recording and controlling. Meters can be located as far as 200 feet from electrode assemblies.

**3. The Recorder** Beckman pH instruments may be used with all leading makes of recording and controlling equipment. The recorder is connected to the pH meter and charts a permanent record. It may be mounted in a central control room at any distance from the meter.



For more data on advertised products, use Readers' Service Cards, last page.



# For reforming natural gas **Stainless Steel**

If you could peek inside equipment used for production of synthetic gas and hydrogen, you would see a veritable showplace for Stainless Steel.

Without Stainless Steel tubing and devices, maintenance costs would go through the roof. With Stainless Steel, the greatest freedom from severe petrochemical service is the usual result.

Of course, there is the job of selecting just the right Stainless Steel composition . . . the composition with the best performance cost ratio. This problem is discussed in our booklet, "Performance of Stainless Steel in Petroleum Refinery Service."

Your copy is waiting. Just write to United States Steel, Room 5162, 525 William Penn Place, Pittsburgh 30, Pa., and we shall be glad to send you a copy.

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# Reviewing New Books . . .

**Engineers Job Directory,** 1956 Edition. This directory contains a complete list of companies having available job openings. The book lists the requirements of 236 major firms in the U. S. which are seeking personnel, and offers information concerning these companies, their policies and products.

The information was gathered with the cooperation of the companies listed. Personnel, engineering and research directors outlined their company policies, products and locations.

A typical company listing gives its correct firm name, its address and date of founding. The products it produces are outlined as well as the industry in which it belongs. Indicating the size of the company is its number of employes. The name and title of the company official to whom job inquiries should be directed rounds out the information.

(Decision, Inc., 1483 First National Bank Building, Cincinnati 2, $3.25.)

**Reactions of Carbon with Carbon Dioxide and with Steam,** prepared by the Institute of Gas Technology. Studies of high-temperature reactions between a solid fuel and oxidizing gases are presented as:

- The development of mathematical procedures which may have general use in estimating chemical and physical factors associated with carbon gasification.
- Application of these procedures to the interpretation of steam and carbon-dioxide decomposition rates and gas analyses derived from experimental data obtained fixed-bed reactors at atmospheric and superatmospheric pressures, and from a cycle flow fixed-bed water-gas generator operating at atmospheric pressure.

(Institute of Gas Technology, Illinois Institute of Technology, Chicago 16, 75 pages, $7.50.)

**You and the Instrument Industry,** prepared by the Scientific Apparatus Makers Association. This booklet, summing up the purposes of the SAMA, shows the need for active membership in professional societies, and goes on to present an argument for joining such trade associations as the SAMA. It defines the objectives of trade organizations in the American economy, with sections devoted to SAMA services, committees, organization, and how non-members can profit by joining SAMA.

(Scientific Apparatus Makers Association, 20 North Wacker Drive, Chicago 6, 16 pages, free of charge.)

**Standard Oil Company (Indiana): Oil Pioneer of the Middle West,** by Paul H. Giddens. One of the most sensational industrial controversies in the history of American business, the proxy battle waged by John D. Rockefeller, Jr., to oust Col. Robert W. Stewart as chairman of the board of Standard Oil Company (Indiana) is recalled in this new book.

It is a completed documented history of the company from its inception in 1889, as a part of the Standard Oil group, to the end of 1951.

Among other high points in American business history that Dr. Giddens deals with are Judge Kenesaw Mountain Landis' famous $29 million fine (later removed) imposed on Standard of Indiana; the hectic period that led to the dissolution of the Standard Oil Company of New Jersey, a holding company that controlled 33 other Rockefeller companies, and the development of the Burton cracking process which doubled the gasoline supply of the world.

The emergence of Standard of Indiana in 1911 as a separate and independent company and its growth into a fully integrated oil company, is covered in detail by the author, who also reviews the great contributions the company has made through scientific research, and the important role the organization has played in the development of the petroleum industry, the nation and especially to the growth of the Middle West to economic maturity.

(Appleton-Century-Crofts, Inc., 35 West 32nd Street, New York 1, 726 pages, $7.50.)

**Production Control Through Electronic Data Processing:** A Case History, by R. G. Canning. This paper, Research Report Number 30, was prepared while the author was under contract to the Office of Naval Research, and working on the Management Sciences Research Project at the University of California, Los Angeles.

The report considers briefly some of the major principles involved applying new electronic computers to business operations. Then, to illustrate the application of these principles, the report describes an in-plant research study, made at a medium sized manufacturing plant in the Los Angeles area.

The purposed processing system has not been based upon any particular electronic computor. On the other hand, the paper presents those characteristics which would be desired for the production control application in a particular case.

(Office of Technical Services, Department of Commerce, Washington 25, D. C., Report Number PD111580, 52 pages, $1.50.)

**National Survey of Burner-Fuel Oils, 1955,** by O. C. Blade. This survey is issued to provide information on the characteristics of burner-fuel oils now manufactured for sale. The survey is the first for this type of fuel. It is not intended to conflict with the diesel-fuel survey published annually since 1950, by the Bureau of Mines, and the American Petroleum Institute. Rather, it is intended to supplement the diesel-fuel survey.

Data on a total of 341 samples of burner-fuel oil are represented. The fuels were manufactured by 35 petroleum refining companies, large and small, in 97 refineries throughout the country.

(Bureau of Mines, U. S. Department of the Interior, Information Circular 7730.)

**Fuels and Fuel Systems,** by technologist of the Phillips Petroleum Company. This publication contributes to an understanding of the basic problems of vapor lock in automotive vehicles. It gives a critical review of the results of over 20 years of road testing by the petroleum industry. An interpretation is made of the

UNMATCHED ACCURACY
in a package
Everything you need . . . for field instrument calibration
MERIAM Manometer Kits
★ Magnifying sight glass
★ Mirror for resolving parallax
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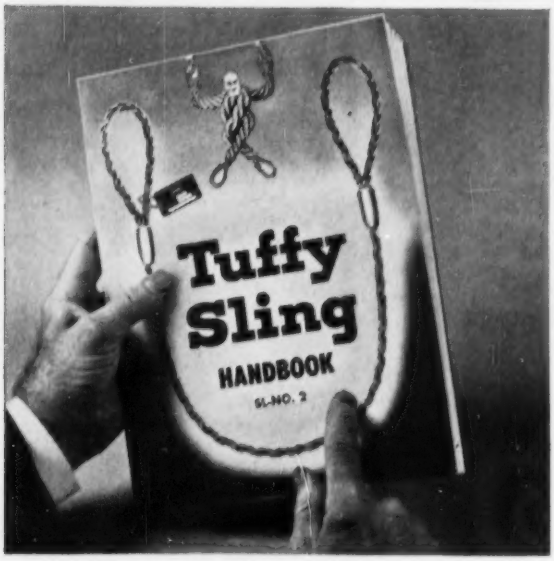
# Tuffy® SLING NEWS

Vol. 1 — Published Monthly in Leading American Trade Magazines by Union Wire Rope Corp. — No. 3


# NEW FERRULE EYE SPLICE FEATURED

## In Big, New Tuffy Sling Handbook Just Off Press-FREE




First editions of this handbook were so popular that 85,000 copies circulated to sling users. If you use or buy slings—if you're a plant engineer, safety engineer or purchasing agent—you'll find this new, enlarged edition of the Tuffy Sling Handbook the most comprehensive ever published.

It tells you all about the new factory-fitted slings added to the Tuffy line. It shows why the new Tuffy pressed-on ferrule makes Tuffy slings faster, safer, and easier to load and unload than ever before. Many of the fittings—clamps, hooks, bridles, thimbles, saddles—are new, too. And this latest edition of the Tuffy Sling Handbook contains a host of other useful information: a complete rigger's manual, proof tested ratings and specifications for all Tuffy Slings; a new engineer's notebook; data tables on a full line of versatile, easy-to-apply sling fittings.

**But don't delay** to order your *FREE* copy. Mail the coupon to us now. We'll send it to you by return mail with Tuffy's compliments—nothing to buy, no obligation. Hurry. The supply is limited!

### YOU CAN'T HURT A TUFFY SLING

Loop it, pull the loop taut. Tuffy's 9-part machine braided wire fabric construction resists kinking. But if you *are* able to kink it, you can straighten it out quickly and without materially damaging the fabric.

### New Tuffy® Ferrule Makes Sling History

It's on all Tuffy Slings, but it doesn't cost you a penny extra. There's no sling ferrule like it anywhere. Tuffy's streamlined metal ferrule is set on the eye splice under pressure so great that the inner metal virtually flows into the voids between the wire fabric. A force of friction is created so great that the eye splice has strength equal to that of the famous machine braided Tuffy wire fabric. It makes Tuffy Slings stronger. It makes them safer: The ends of the tapered ferrule are swaged tightly to the fabric leaving no edges to hang up on loads or to injure workers' hands in hitching to and unhitching from sling loads. There's still another advantage—because Tuffy Slings are easier and safer to load, they're also faster to load. Your men can do more work when they're working with Tuffy Slings.

### CONSULT YOUR DISTRIBUTOR

when you want to buy Tuffy Slings or Tuffy Hoist Lines. Give him your requirements. He'll stock an inventory for you to draw against. It saves you time and money.

### New Tuffy® Ferrule

has no sharp edges to injure hands or catch on loads. The tapered and rounded ends are swaged tight to the sling fabric. The tremendous pressure at which the ferrule is pressed around the machine braided wire fabric flows the metal into the voids of the eye splice and gives the eye splice 100 percent of the strength of the fabric.

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## New Books . . .

available information in terms of limiting fuel system characteristics.

The book does not imply that all the answers to the vapor lock problem have been found. Rather, it is intended to reduce the vapor lock problem to workable engineering principles.

(National Gasoline Association of America, 421 Kennedy Building, Tulsa 3, Okla.)

**Survey of Raw Materials for Petrochemicals in the State of Kansas,** prepared by Midwest Research Institute. This report, prepared for the Kansas Industrial Development Commission, predicts that Kansas will become a leading producer of the raw materials needed in the manufacture of petrochemicals.

The most outstanding change in the Kansas refinery picture is the future production of aromatics and hydrogen along with the possibility of getting valuable materials from what is now waste matter.

The conversion of natural gasoline to aromatics by catalytic reforming will enable the natural gasoline plants to make either high octane gasolines or to produce aromatics such as benzene and toluene for the chemical market. In addition, the LPG products can be cracked to provide the building-block chemicals upon which the petrochemical industry is based.

(Kansas Industrial Development Commission, 1025 Kansas Avenue, Topeka, 20 pages.)

**Britain Views Our Industrial Relations,** by Mark J. Fitzgerald, C. S. C. The findings in this study are based on an analysis of over 60 reports of select British union-management teams which visited their counterpart industries in the U. S. The membership of these teams, over 900 representatives of management and unions, collectively made observations in plants and enterprises in this country. The author gleaned many points for his book from personal interviews with team members in England.

Some topics of current interest discussed in the volume are management policy on industrial relations, the role of unions in American industry, wage standards in America and methods of income distribution. Attention is given to the increasing importance management is attaching to departments of industrial relations in American companies and the care taken to maintain active two-way communications between management and workers.

(University of Notre Dame Press, Notre Dame, Ind., $4.25.)

**Bibliography on Machinery Foundations; Design, Construction, Vibration Elimination,** prepared by The Engineering Societies Library.

This is a revised list of 175 annotated references to selected books and periodical articles published from 1924 to 1955. They cover theory, design and construction of machinery foundations; specific problems such as heavy machinery foundations on unstable soils; and vibration as related to foundations of hammers, oil engines, electrical machinery, turbines, steam engines, compressors, machine tools, pumps, presses, etc.

(The Engineering Societies Library, 29 West 39th Street, New York 18, $2.)

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that Paracoil builds

for industrial needs

A 13,000 cfm direct-fired air preheater being assembled at our Elizabeth plant. The stainless steel combustion chamber (not shown) sets below the tube banks. Air exit temperature 1000° F.

**OUR EXPERIENCED ENGINEERS** are available to expedite planning and specification work and to suggest the most suitable and economical exchanger design.

**MODERN MANUFACTURING** facilities and advanced techniques, skilled and seasoned shop personnel guarantee fabrication to rigid specifications.

**FAST DELIVERY** is assured by efficient shop work and immediate transportation facilities.

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Since 1915 . . . Paracoil's skill to do comes of doing . . . Since 1915




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*Saves you time . . .*
*avoids boiler breakdown*

Reduce maintenance time on boiler water-level gauges. For every gauge in your plant, order *two* spare gauge glasses.

Why? Here's why:

**Spare No. 1** is handy for you when you need a gauge glass for regular replacement during routine maintenance.

**Spare No. 2** is your emergency protection against lost time, if you should suddenly need a replacement because of accidental breakage.

**CORNING INDUSTRIAL GLASSWARE FOR EVERY JOB**

| Application | Recommended Product |
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| Normal conditions (Up to 100 p.s.i.) | CORNING brand standard gauge glasses |
| Higher temperatures | PYREX brand high-pressure gauge glasses |
| Higher pressures | PYREX brand heavy-wall gauge glasses |
| Extra visibility | PYREX brand red-line gauge glasses |
| Viewing inside furnace, reactors, pressure vessels, etc. | PYREX brand sight glasses |
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# Heard at Meetings . . .

## Rheology[1] . . .

**The mechanism** by which a metal stores the energy of cold work was discussed. Data on the dynamic elastic modulus and plastic deformation of copper were presented in terms of theoretically-predicted effects of interstitials and vacancies. These topics as others concerning rheology were discussed. The study of the deformation of the earth and flow patterns in glacier ice indicates a growing interest in rheology.

The importance of rheological studies in relation to the behavior of the human body was demonstrated by data presented on the flow of synovial fluid in health and disease.

Rheology problems can be approached mathematically. This was demonstrated in papers dealing with hypo-elasticity, the stability of flow of incompressible visco-elastic fluids and the mechanical behavior of fibers.

Developments in the study of the visco-elastic properties of high-polymers was the subject of one session. The use of stress-strain curves to characterize the properties of polyisobutylene and a testing method for determining the dynamic mechanical properties of plastics was presented with data on the behavior of polymethyl methacrylate. A method of determining the dynamic bulk modulus was described together with data taken over a wide frequency range on several rubber-sulfur mixtures. The similarity between the behavior of melts and polymer solutions was demonstrated with data on molten polyethylene.

A description of a vibratory gyro mass flowmeter and a method for the determination of structure in dispersions by viscometry was presented. The gradient dependence of intrinsic viscosity was discussed in reference to the determination of the flow inside the space occupied by the macromolecule. Fracture in visco-electric liquids under shear stress was demonstrated with data taken on the extrusion of melted plastics through capillaries and slits.

[1] The Society of Rheology, New York, N. Y., November 2-4.

## Horsepower Race[2] . . .

**New manifold design** methods will help obtain smoother operating engines, higher over-all efficiency, and more engine horsepower.

When a fluid stream enters or leaves a straight pipe manifold with several right angle feeder pipes the main stream is not equally distributed. This non-uniformity has been computed from fluid mechanical equations both for blowing and for sucking manifolds and the results generalized to permit design calculations in which the deviations from uniform distribution do not exceed any set limit.

Observed flow distributions confirm the new methods. They will permit more advanced scientific design of exhaust and intake manifolds, and will lead to investigation of waterpower plant intakes for improved use of waterpower resources. (A. Acrivos, B. D. Babcock and R. L. Pigford, University of Delaware.)

## Personnel Testing[3] . . .

**Industrial and business** executives and other top management personnel will take part in the five-day session. The program will include a practical workshop for personnel appraisal problems, lectures by staff members and representatives from industry, informal discussion groups and individual conferences.

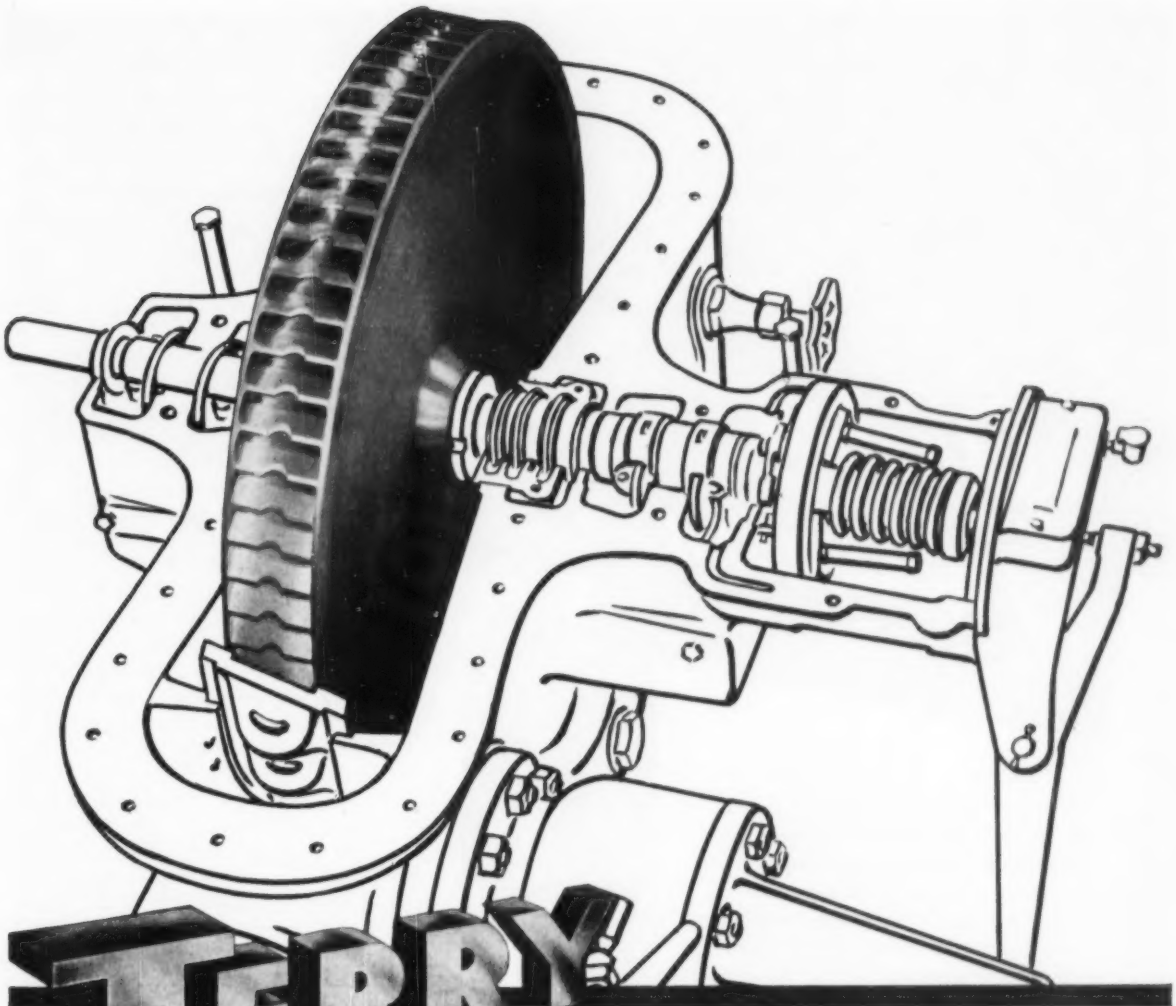
Major emphasis will be given, by both staff members and business and industrial representatives, to discussion of actual results obtained from recent cooperative research and development projects. These projects include more than 350 individual appraisals of management personnel in railroad, automotive, petroleum and chemical companies and technical personnel in the petroleum, chemical and electrical industry.

An appraisal of various factors involved in the selection, placement, development and promotion of personnel will be presented. Special areas

[2] A.I.Ch.E., Detroit, November 27-30.

[3] Personnel Testing Institute, Rensselaer Polytechnic Institute, Troy, N. Y., January 16-20.


For more data on advertised products, use Readers' Service Cards, last page.

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## is your turbine dividend

The rugged construction and fool-proof design of a Terry solid-wheel turbine can save you money by keeping maintenance costs to a minimum. Usually only taken down for routine inspection, any repairs that must be made are of relatively simple nature, and cost of replacement parts is small.

The rotor of the turbine is a single forging of special composition steel, in which a series of semi-circular buckets is milled. There are no separate parts to loosen or work out. As the only function of the blades is to form a series of pockets, any wear which might occur would not materially affect horsepower or efficiency.

It is impossible for the blades to foul. They have large clearances and are further protected by the projecting rims of the sides of the wheel. As the side clearances are also very large, end play can do no harm.

The Terry solid-wheel turbine is an extremely reliable piece of equipment—why not write for complete details today? Ask for a copy of Bulletin S-116.

**THE TERRY STEAM TURBINE COMPANY**
**TERRY SQUARE, HARTFORD 1, CONN.**

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Whether its a kettle, reboiler, reactor or other process equipment, Manning & Lewis engineers and craftsmen are ready to design and fabricate a unit, tailor-made to fit your particular process need, and priced to fit your budget.

You need only supply the performance requirements. An experienced M & L engineer will take it from there and specify type, size, method of construction, etc.—all the essentials that have made Manning & Lewis equipment preferred in plants from coast to coast.

Send your inquiry or have a M & L representative call.

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## Who's Meeting . . .

to be covered will include tests for ability, interest, personality and attitude.

### Atomic Research[4] . . .

**Chemical Synthesis**—When pure water is subjected to gamma radiation, $H^{\cdot}$ and $OH^{\cdot}$ radicals are formed. Experiments with these radicals based on reacting ethylene produced acetaldehyde, ethanol, acetic acid and hydrogen peroxide. (Ernest J. Henley, Jane P. Schwartz and Wesley P. Schiffries, Columbia University.)

The rates of chlorination of toluene under the influence of gamma radiation have been studied. (Joseph J. Martin and Leigh C. Anderson, University of Michigan.)

**Fluid Mechanics**—Periodic oscillations in the performance of a natural circulation pipe-line loop, filled with water heated by a heat exchanger within the loop itself, were induced and studied. This work is of interest for emergency cooling of reactors and in the design of boiling-water reactors. It also may be of value in conventional boiler design. A theoretical analysis was made of the problem, with computer solutions. (Eugene H. Wissler, H. S. Isbin and N. R. Amundson, University of Minnesota.)

### Uniterm Index[5] . . .

**A fingertip source** of complete information will soon be issued, covering 6000 chemical patents issued in the U. S. during 1955. Current plans for back indexing all chemical patents now in force are being made, providing subscribers to this service with a complete 17-year continuity of chemical patents.

The use and management of patent data has for years been a high-cost factor to industry. The Uniterm Index, representing millions of dollars worth of knowledge, is a practical, easy-to-use system designed to make all chemical patent information cheaply and readily available.

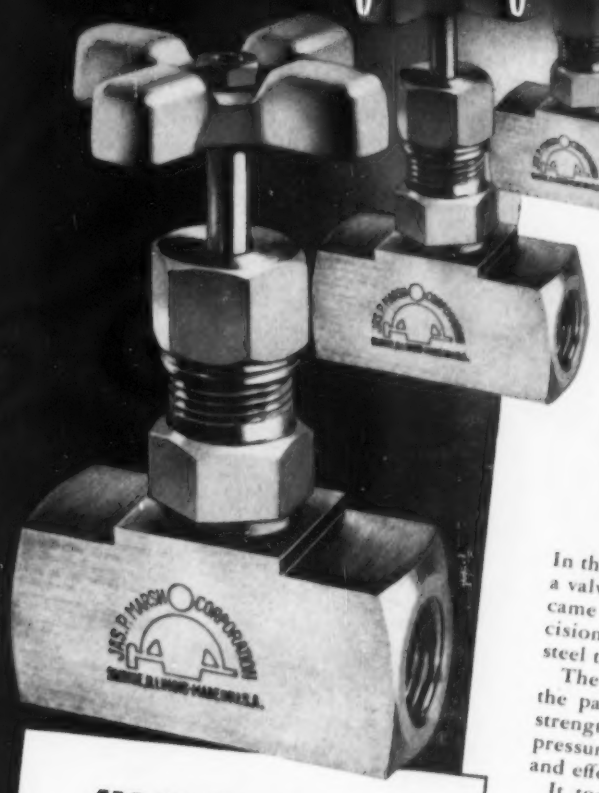
Companies represented at the conference included American Viscose Corporation, Celanese Corporation, Davison Chemical Company, E. I. duPont de Nemours & Company, The Dow Chemical Company, Humble Oil

[4] Nuclear Engineering and Science Congress, Cleveland, December 12-16.

[5] Information for Industry, Inc., Washington, D. C., December 5-6.


For more data on advertised products, use Readers' Service Cards, last page.

# Now the finest of needle valves is available




## 416 Stainless throughout...

In the Marsh Needle Valve, operating men found a valve that was better all the way through. Then came the call for a valve of like quality and precision for corrosion service . . . to be 416 stainless steel throughout.

The valve illustrated here is the answer. Like the parent valve, this new valve has safety and strength to spare . . . guaranteed for working pressures up to 10,000 psi . . . equally efficient and effective in any lower pressure range.

It too is machined from solid bar stock—in this case, 416 stainless steel. Its precision-ground and-machined stem is hardened 416 stainless. Packing is the special "Marpak" ring . . . one-piece, non-binding, long-lasting. So finely built is this needle throttling and cut-off valve that it can be easily throttled down to exceptionally fine regulation even on extreme pressure.

Read the list of features opposite. Then write for new bulletin No. NV-2 containing complete details.

**416 Stainless Steel**
**...all the way through!**

- Body and stem guide machined from bar stock.
- Valve stem, hardened stainless.
- Packing, special Marsh "Marpak" moulded ring.
- Fine stem threads for strength and precision throttling.
- Deep inlet and outlet thread chambers.
- Bodies marked in accordance with MSS regulations.

**Maximum Working Pressure 10,000 P.S.I.**

Water, oil, gas or corrosive fluids not injurious to 416 stainless steel.

The new all stainless valves (Series 1924) includes globe and angle patterns with double female connections in sizes ⅛", ¼", ⅜", ½", ¾", 1"; also globe and angle valves with male inlet and female outlet in sizes ¼" and ½".

**MARSH INSTRUMENT CO.** Dept. R, Skokie, Ill.
Sales affiliate of Jas. P. Marsh Corp.

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**MARSH**

"THE STANDARD OF ACCURACY"




For more data on advertised products, use Readers' Service Cards, last page.

## Who's Meeting . . .

& Refining Company, Imperial Oil, Ltd., The Pure Oil Company, Standard Oil Company (Indiana), and Union Carbide & Carbon Chemical Company.

### Use of Tracers[6] . . .

**Radioactive tracers** are being used more and more in automotive research. These techniques permit a sensitive and quick method of measuring engine wear that cannot be done by using other known methods. (A. Hundere, G. C. Lawrason and J. P. O'Meara, Southwest Research Institute.)

**This new tool** was used recently to measure engine deposits as thin as ten millionths of an inch. Also deposition rate can be indicated after only a few hours instead of ten or hundreds of hours by conventional methods. (J. G. Mingle, H. W. Sigworth and B. A. Fries, California Research Corporation.)

**Metal transfer** between electrical contacts has been measured accurately by this method. The new research technique is so accurate that a teaspoonful of radioactive salt dissolved in Lake Erie could be detected and measured. (C. R. Lewis, Chrysler Corporation.)

**The technique** consists of activating arc engine part in a nuclear reactor, then assembling it into an engine. As the engine is operated any wear in the original part can be detected with a Geiger counter. The technique is varied slightly to obtain different types of data.

[6] Nuclear Engineering and Science Congress, Cleveland, December 12-16.

ARCCO
ARCCO-Anubis
CONTINUOUS GAS SAMPLER
MEETING THE DEMAND for more accurate gas sampling, this newly perfected ARCCO-Anubis instrument replaces inadequate, inaccurate spot sampling methods. The Model 100-7 will over a period of seven days accumulate at a constant rate a sample of gas to a final pressure at or near 100 psig from a sample source, the minimum pressure of which is not less than 125 psig.
The ARCCO-Anubis design is based on the principle that maintenance of a constant rate of increase in gas pressure within a closed container, from zero to any selected maximum pressure, will result in a continuous rate of flow of gas into the closed container.
This is accomplished by means of a specially designed regulation system equipped with a precision drive mechanism so as to obtain a constant predetermined rate of increase in the outlet pressure into the sample container.
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### The Decade Ahead[7] . . .

**Annual meeting** of the Society of Automotive Engineers was highlighted by a discussion on the next decade and the automobile. This session included as speakers four members of the University of Michigan faculty who discussed the automotive gas turbine and changes to be expected in engines.

The society also heard as its principal guest speaker Secretary of the Army Wilbert M. Brucker.

The meeting included a review of automation and its effect on design and manufacture. At this session, executives dramatized the problems created for management by the incident of automation.

Among those participating were A. T. Colwell, vice president of Thompson Products, Inc.; R. T. Hurley, president of Curtiss-Wright Corporation; E. N. Cole, chief engineer for Chevrolet Motor division of General Motors Corporation, and M. P. Ferguson, president of Bendix Aviation Corporation.

Other subjects considered included preventive maintenance methods, automotive-engineering education; horsepower losses and turbine-engine maintenance.

### In the Future . . .

One session will be devoted to papers on plant maintenance and mechanical organization of refineries and petrochemical plants. Other topics to be taken up will include "Human Engineering," "Practical Approach to Engineering Designs" and "Proper Balances Between Safety, Convenience and Economy in Preparing Engineering Designs." (ASME, Dallas, September, 1956.)

[7] SAE, Detroit, January 9-13.

# HERE'S WHAT WOLVERINE TRUFIN* WILL DO FOR YOU . . .

## TRUFIN*

- STEPS UP HEAT TRANSFER EFFICIENCY
- SAVES TIME
- SAVES MONEY
- SAVES VALUABLE SPACE

Yes, if you want more heat transfer efficiency—want to save time, money and space—here's a tip for you. Investigate, today, the possibilities of Wolverine Trufin Type S/T condenser tube.

Type S/T is an extended surface condenser tube. Its extruded fins—providing greater heat transfer surface—are actually part of the tube wall. A ¾ inch Type S/T condenser tube, for example, has an external-to-internal surface ratio of 3½ to 1. *It has approximately 2½ times the outside surface of the ¾ inch prime surface tube it is designed to replace.* That means increased capacity—more BTU's from every foot of tube.

When an installation tubed with Trufin goes on stream—it stays on stream longer. Because the fins are part of the tube, they can't shake loose from vibration, thermal shock or pressure fluctuations. Actual operating data and pilot plant research indicate that Trufin Type S/T actually resists the deposition of fouling materials. Maintenance costs go down—and stay down. When specified for new units, Trufin Type S/T permits the designing of smaller, more effective heat exchangers and condensers. You save space and you spend fewer dollars.

Type S/T—when specified as replacement tube—packs more heat transfer surface into existing units, steps up capacity far above original output. It can be directly substituted for prime surface tube without any deviation from standard retubing techniques.

And there—in brief—is what Wolverine Trufin Type S/T will do for you. Put it to the test—specify Type S/T—for both new units and when retubing existing units. Wolverine's new Processing Flowsheets Catalog shows exactly where Type S/T is being used and can be used in the industry. Write for your copy—TODAY.

Wolverine Tube, 1437 Central Ave., Detroit 9, Mich.

*REG. U. S. PAT. OFF.

*Wolverine Trufin available in Canada through the Unifin Tube Company, London, Ontario.*

**WOLVERINE TUBE**

Division of Calumet & Hecla, Inc.

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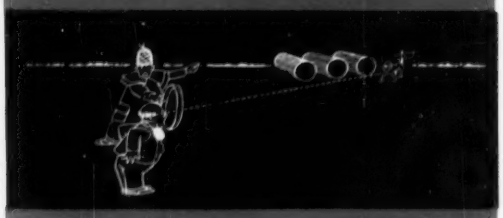
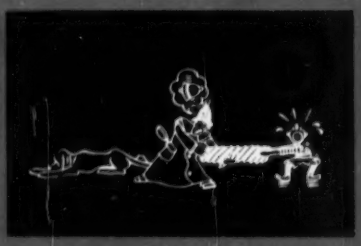
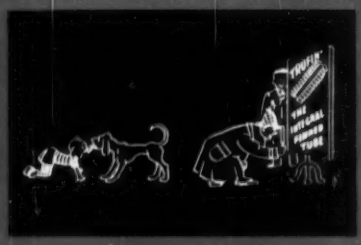
PLANTS IN DETROIT, MICHIGAN, AND DECATUR, ALABAMA. SALES OFFICES IN PRINCIPAL CITIES

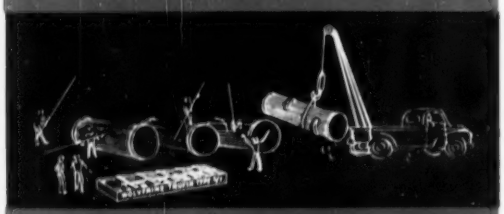
EXPORT DEPARTMENT, 15 EAST 40TH STREET, NEW YORK 16, NEW YORK

# THE CASE OF THE KIDNAPPED CONDENSER







"See that vacant space out there—just to the right of those three condensers. It used to be occupied by No. 4 condenser—but not any more. Good old No. 4 is gone—kidnapped by a piece of licorice.

"What's that you say? It sounds like a mystery story with a trick ending. Well, in a way it is. It all started eight months ago when home office began screaming for more production. I'm telling you our whole engineering department sat up nights trying to figure it out. We just couldn't see how we could boost output—short of building a new plant, that is.

"Then we got our first real break. I'm sitting home one night—dead tired—when Johnny, my five-year old son walks in. Is he a mess. He's chewing on a piece of licorice—and it's smeared all over him.

"I start to take it away from him—when something about that licorice rings a bell in my mind. It's the way it looks—sort of like a piece of tube—*with fins!*

"Then it comes to me—something a Wolverine salesman had mentioned one day in my office. 'Wolverine Trufin*,' he said, 'is an extended surface condenser tube with integral helical fins squeezed right from the tube wall. Because of the fins, Trufin has much greater capacity than prime surface tube.'

"That was the clue we were looking for. We pulled a condenser and retubed with Trufin Type S/T. The results were terrific. Right away heat load jumped from 417,000 BTU's per hour to 829,000. You can just bet that No. 2 and No. 3 got the same Trufin treatment. No. 4 got the gate—we just don't need it anymore. You might say that it was kidnapped by Trufin Type S/T—and a piece of licorice."

Next time you retube—specify Wolverine Trufin Type S/T—see how it can solve heat exchange and condensing problems in your plant. Write, too, for the new Trufin Opportunity Book. It's filled with valuable design information and actual Trufin case histories.

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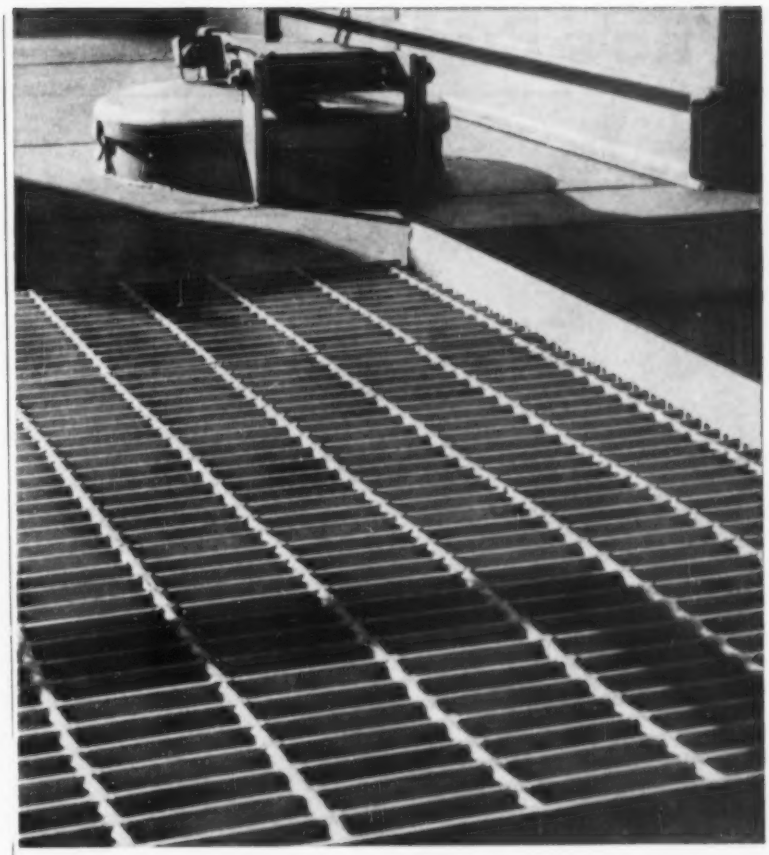
EXPORT DEPARTMENT, 13 EAST 40TH STREET, NEW YORK 16, NEW YORK.

## MEETINGS CALENDAR

| | |
|---|---|
| JAN. | |
| 19–20 | National Industrial Conference Board, Commodore Hotel, New York. |
| 23–26 | Plant Maintenance and Engineering Show, Convention Hall, Philadelphia. |
| 25–26 | Northwest Petroleum Association (Annual Convention), Nicollette Hotel, Minneapolis, Minn. |
| 25–27 | Instrumentation for the Process Industries Symposium, Sponsored by the Chemical Engineering Department, Texas A&M College, College Station, Texas. |
| 26–27 | Plan Maintenance and Engineering Conference, Warwick Hotel, Philadelphia. |
| 30–31 | Industrial Economics Conference, Sponsored by Stanford Research Institute, Statler Hotel, Los Angeles. |
| 30–Feb. 3 | American Institute of Electrical Engineers (General Meeting), Hotel Statler, New York. |
| 31–Feb. 1 | Chemical and Market Research Association (Aromatic Chemical Meeting), Webster Hotel, Pittsburgh. |
| FEB. | |
| 1– 3 | Corrosion Short Course, Sponsored by Institute Technologico y de Estudios Superiores de Monterrey, Monterrey, Mexico. |
| 12–18 | Statistics Short Course for Industry and Physical Sciences, jointly sponsored by the University of North Carolina, North Carolina State College and The Women's College, at North Carolina State College, Raleigh, N. C. |
| 24 | Natural Gasoline Association of America (Regional Meeting), Lincoln Hotel, Odessa, Texas. |
| 24–25 | National Society of Professional Engineers (Spring Meeting), Statler Hotel, Washington, D.C. |
| 26–29 | American Institute of Chemical Engineers, Statler Hotel, Los Angeles. |
| 27–Mar. 2 | American Society for Testing Materials (Committee Week), Statler Hotel, Buffalo, New York. |
| MAR. | |
| 5– 7 | Chemical Institute of Canada (Divisional Conference), Guildwood Inn, Sarnia, Ont. |
| 12–16 | National Association of Corrosion Engineers (Annual Convention), Statler Hotel, New York. |
| 19–21 | Mid-West Gas Association, Hotel Fontenelle, Omaha, Neb. |
| 19–21 | Western Petroleum Refiners Association (Annual Meeting), Plaza Hotel, San Antonio, Texas. |
| 21–23 | Annual American Power Conference, Sponsored by Illinois Institute of Technology, Hotel Sherman, Chicago. |
| APRIL | |
| 2– 4 | American Institute of Electrical Engineers (Southwest District 7), Dallas, Texas. |
| 8–11 | American Chemical Society (National Meeting), Dallas, Texas |
| 11–13 | Natural Gasoline Association of America (Annual Convention), Texas Hotel, Fort Worth, Texas. |
| 17–19 | Southwestern Gas Measurement Short Course, University of Oklahoma, Norman, Oklahoma. |
| 18–20 | National Petroleum Association (Semi-Annual Meeting), Cleveland Hotel, Cleveland, Ohio. |
| 23–25 | Chemical Progress Week. |
| 25 | Association of Consulting Chemists and Chemical Engineers (Symposium), Belmont Plaza, New York. |
| 26–27 | American Institute of Electrical Engineers (National Meeting), Bradford Hotel, Boston. |
| 30–May 4 | American Petroleum Institute (Safety and Fire Protection Mid-Year Meeting), Warwick Hotel, Philadelphia. |
| MAY | |
| 6– 9 | Liquefied Petroleum Gas Association (Convention and Trade Show), Conrad Hilton Hotel, Chicago. |
| 6– 9 | American Institute of Chemical Engineers, Roosevelt Hotel, New Orleans. |
| 14–17 | American Petroleum Institute, Division of Refining (Mid-Year Meeting), Sheraton-Mount Royal Hotel, Montreal, Conada. |
| 28–30 | Chemical Institute of Canada (Annual Conference and Exhibition), Mount Royal Hotel, Montreal, Quebec. |

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Indoors or outdoors, you can provide safe walking conditions throughout your plant on floors, stair treads, platforms, walkways and catwalks. For Blaw-Knox Electroforged Steel Grating brings you these exclusive features:

1. rigid one-piece construction—easy to install
2. non-slip twisted crossbar—for safe footing
3. three types of bearing bars
   - square bars—for smoothest walking surface
   - knurled bars (Furro-Grip)—for extra safety plus relatively smooth walking surface
   - serrated bars—for maximum safety under extremely hazardous skid conditions
4. no sharp corners to clog—self-cleaning
5. all surfaces accessible—easy to paint
6. maximum open area—for light and ventilation

*Write for your copy of new Bulletin No. 2486 —or send dimensional sketch for quotation.*

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**BLAW-KNOX EQUIPMENT DIVISION**

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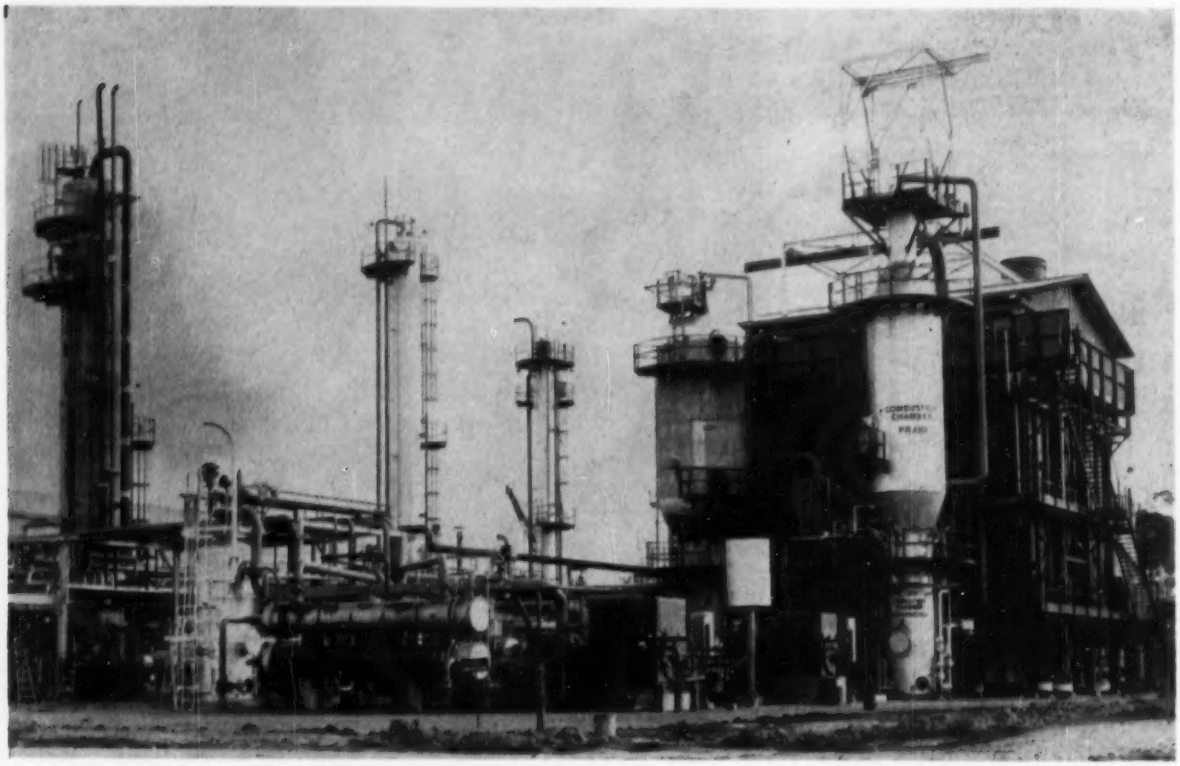
**GRATING APPLICATIONS:** floors • platforms • walkways • catwalks • stair treads • fan guards • shelving • and many other uses, both outdoors and indoors, for versatile steel grating




For more data on advertised products, use Readers' Service Cards, last page.

# Who's Building . . .

Construction Boxscore Starts on Page 213



A view of Sohio's new ammonia plant.

## Sohio Enters Petrochemicals With New $17-Million Plant

**. . . Carbon-dioxide facilities due to go on stream in April.**

PETROCHEMICAL production has started at The Standard Oil Company (Ohio) plant in Lima, Ohio. The company's first venture into the petrochemical field, the $17-million plant will be operated by a new subsidiary, Sohio Chemical Company.

It will turn out 300-tons a day of anhydrous ammonia, 180 tons of nitric acid, 120 tons of urea and 200 tons of ammonium nitrate-ammonia solutions.

Still under construction at Lima is the company's 75-ton-a-day dry-ice plant. The carbon-dioxide facilities, expected to cost $800,000 will go on stream in April.

**The ammonia plant,** a 300-ton-a-day installation, turns out a product channeled for the manufacture of nitric acid and nitrogen solutions, while a high-purity carbon dioxide byproduct will be used for urea synthesis and the liquid carbon-dioxide and dry-ice plant.

This new plant was designed to use The M. W. Kellogg process of steam methane pressure reforming, in which natural gas and refinery gas are used as starting materials.

In general, this process introduces a number of design innovations to ammonia production. It anticipates:

- A reforming step which saves 25 to 35 percent in compressor horsepower.
- A special quench-type reactor which allows optimum temperature control and contributes to improved yields and lower operating costs.
- Close control of temperature in the reactor leads to longer cata-

# WHEN TO DEMAND THIS DYNAMIC SEAL

There's a time to *insist* on Flexitallic Gaskets and *this* is it:

(1) When fluids are confined in critical pressure/temperature ranges

(2) When flanged joints are subject to thermal and physical shock, corrosion, vibration, weaving and unpredictable stresses

Since 1912, Flexitallic has made only one product — a Spiral-Wound Gasket, built on the original Flexitallic principle. It's a uniquely resilient construction that compresses under the applied load, adjusts itself to changes in operating conditions without affecting gasket efficiency and then rebounds when bolting is relaxed.

That is why more and more engineers are marking their purchase orders: "Flexitallic — do not substitute."

Each Flexitallic Gasket is designed and engineered to meet specific conditions. Spirally-wound V-crimped plies of required metal with alternating plies of proper filler result in a resilient gasket having characteristics of a calibrated spring.

Flexitallic Gaskets are at highest efficiency when bolted up cold at a predetermined load. For all pressure/temperature ranges from vacuum to 10,000 lbs., from extreme sub-zero to 2000°F. For all standard joint assemblies. In four thicknesses for special requirements: .125", .175", .250", .285".

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FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

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The ideal seal for many process applications is a Flexitallic Gasket with Teflon trapped between edges of stainless steel. Ask for folder, "Teflon in Flexitallic Gaskets."

*Flexitallic is a registered trade name. No one else can make a Flexitallic Gasket. Look for *Flexitallic Blue*—it's our exclusive blue-dyed Canadian asbestos filler.



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## Who's Building...

lyst life, lower maintenance costs and higher conversion per pass.

**The urea plant**, with a daily capacity of 120 tons, is the first in the U. S. to use the Inventa process developed by Switzerland's Holzveruckerungs, A. G.

Prime contractor for the project was The Vulcan Engineering Division of The Vulcan Copper & Supply Company, which holds the license for the U. S. and Canada on the Inventa process. Arthur G. McKee & Company was constructor.

The process used in this unit is said to overcome two major difficulties which have plagued urea production in the past:

- Extreme and rapid corrosion in the reactor when ammonia and carbon dioxide are combined to form urea.
- The difficulty by separating unreacted carbon dioxide and ammonia.

Without using lead or silver, the Hovag group has selected materials for reactor construction and a technique of reactor operation to combat corrosiveness. In the Sohio unit, the reactor is lined with an alloy which should last 10 or 15 years without requiring frequent replacement, as is the case with lead or silver.

Vulcan's translation of the Inventa process to American design of new plants resulted in a recycle system which is expected to overcome the difficulty of separating unreacted carbon dioxide and ammonia.

**The nitric acid plant**, a 180-ton-a-day facility designed and built by The Chemical and Industrial Corporation, burns ammonia and absorbs the oxides formed under pressure of some 100 psig.

In this unit, the mixture of air and ammonia is burned in the presence of a platinum-rhodium catalyst. The resultant combustion gases are cooled and oxidized, changing NO to $NO_2$; and the acid is absorbed in a water solution.

**The final unit** (ammonium nitrate-ammonia solutions) takes urea tail gas and ammonia purge gas from the urea and ammonia plants, supplying about 80 percent of the ammonia gas required for nitric-acid neutralization. The balance is pure anhydrous liquid ammonia.

If the urea plant is not operating, 100 percent pure ammonia is used for neutralization. Nitric acid is added directly and the resulting heat of reaction concentrates to solution to approximately 83 percent ammonium nitrate.

Liquid ammonia is added to adjust the ammonium nitrate from an acid condition to that of slightly alkaline.

**Pontiac Eastern Corporation** has plans for building a 12,000-barrel-a-day refinery at Hattiesburg, Miss. The plant, to process Mississippi crude produced by Gulf Refining Company, will cost some $18 million to build and put into operation.

Plans call for production of high-octane gasoline, kerosine and LPG products. Principal processing facilities will include electric desalting, tar separation, Thermofor catalytic cracking, fluid coking, gas recovery, sulfuric alkylation, Unifining and Platforming.

The company, a Corpus Christi, Texas, refining concern, has picked The Fluor Corporation, Ltd., to handle engineering and construction on the plant. The project will take about 15 months to complete.

The company also is considering future expansion of its basic plant to include the production of petrochemicals.

**Firestone Tire & Rubber Company** plans construction of a butadiene plant, at an unnamed location. The company also will boost capacity of its Akron, Ohio, synthetic-rubber plant by 35 percent.

The new butadiene plant, to be the company's first, will have an annual capacity of 40,000 tons. A contract for design and construction of the new plant went to Catalytic Construction Company.

The synthetic-rubber plant at Akron, now with an annual capacity of 30,000 tons, will be expanded to bring its output to more than 40,000 tons.

Firestone previously announced that capacity of its Lake Charles, La., synthetic-rubber plant would be increased by 50 percent, raising its output from 100,000 tons a year to 150,000.

When expansion of the Akron and Lake Charles facilities are complete, the company will have a total annual capacity of more than 190,000 tons.

**Cabot of France** will build a carbon-black plant at Berre Lake, in the French refining area. The company was set up by Godfrey L. Cabot, a Boston firm. It plans a 40,000-ton-a-year plant, with a construction schedule calling for the new installation to go on stream in about 15 months. A contract has been concluded with Compagnie Shell Berre, for that company's Berre refinery to furnish basic oil products for processing.

**Shell Chemical Corporation** will expand its synthetic-rubber facilities at Torrance, Calif., to include the production of cold high-solids latex. Construction on the project, to be started immediately, will include additional reactor capacity as well as latex-finishing equipment.

**Suntide Refining Company** is expanding its Corpus Christi, Texas, refinery to make it the U. S.'s largest independent refinery, with a capacity of 65,000 barrels a day. The refinery's present capacity runs 50,000 barrels.

The plant, when it went on stream in 1954, was a little more than 26,000 barrels a day, but it was increased by a series of expansion which were started immediately. Suntide is 50 percent owned by Sunray Mid-Continent Oil Company.

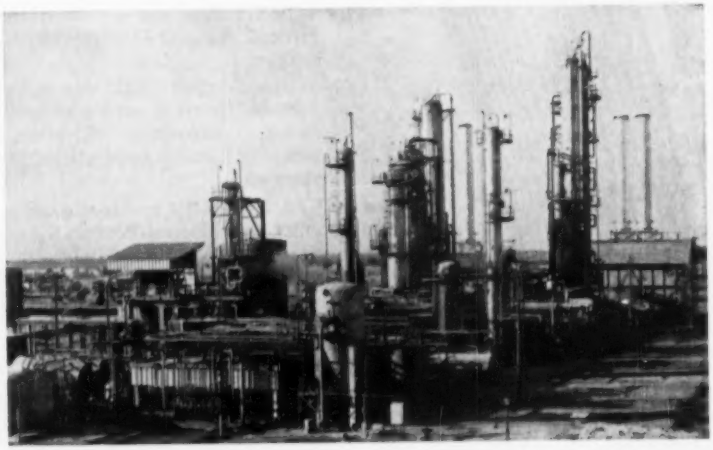
**Standard Oil Company** (Indiana) has started construction on a 14,000-barrel-a-day catalytic reformer at its Whiting, Ind., refinery. The unit, an Ultraformer, is due for completion in April 1956. Construction and engineering is being handled by The Ralph M. Parsons Company.

**Atlas Processing Company** has gone on stream with a second Platforming unit at its Shreveport, La., refinery. With a daily capacity of 3500 barrels, the new reformer was built to produce a 94 leaded octane blending component. The company's first Platformer, a 4400-barrel-a-day unit, went on stream in 1952.

**Commercial Oil Refining Company** will start breaking ground for a 30,000-barrel-a-day refinery at Providence, R. I. The plant, due to cost some $30 million, will produce high-octane gasoline, fuel oil and petroleum by-products.

A second new Rhode Island refinery, also to have a 30,000-barrel-a-day capacity, will be the Paragon Oil Company plant proposed for Tiverton. This com-

## Iraq Refinery on Stream

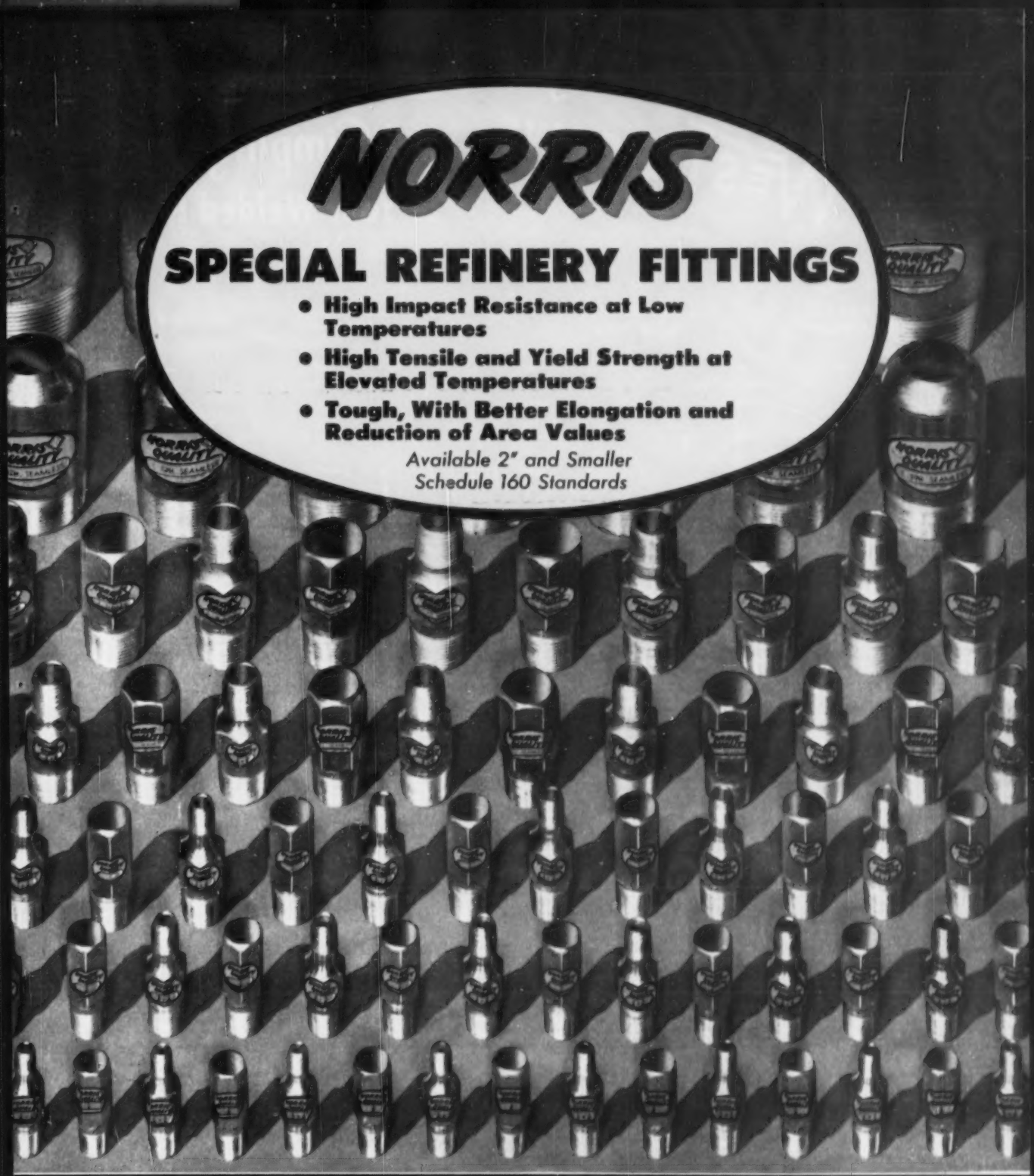


Iraq's first oil refinery, built for the government at Dora, is now on stream. Designed and engineered by The M. W. Kellogg Company, the new 24,000-barrel-a-day thermal refinery processes Kirkuk crude, producing fuel gas, stabilized gasoline, kerosine, light gas oil, diesel oil and residual fuel oil.

A single combination unit intergrates crude atmospheric topping, single-pass visbreaking of reduced crude, thermal cracking of gas oil, thermal reforming of heavy virgin naphtha, vacuum flashing of combined evaporator bottom, gas recovery and the stabilization of combined gasoline. Completing the combination unit are gasoline-treating and kerosine-treating facilities, a power plant and auxiliaries.

The refinery's equipment also includes a sulfuric-acid plant which will reclaim spent acid as well as produce fresh acid for kerosine and water-treating. The can-manufacturing operations will produce and fill 150,000 five-gallon cans a day.

The refinery was built by Kellogg International Corporation. The cost ran more than $30 million.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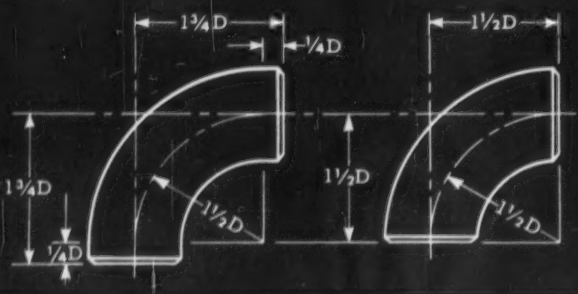
# The Unequalled Variety of MIDWEST ELBOWS will Save Money and Simplify Design of Your Welded Piping

**1 LONG RADIUS LONG TANGENT**




**SIZES: 2" thru 36"**

A premium fitting at the same price as regular long radius elbows, but with LONG TANGENTS on both ends . . . an exclusive Midwest feature that saves time and pipe.

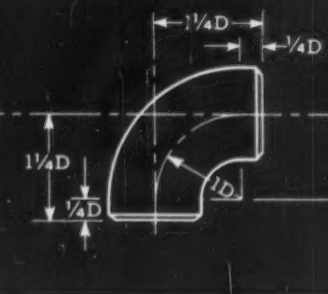
**2 LONG RADIUS ASA TYPE**




**SIZES: ¾" thru 36"**

Dimensions conform to the American Standard for Steel Butt-Welding Fittings, ASA B16.9, and the Manufacturers Standardization Society Specification DS-11.

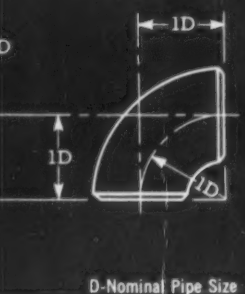
**3 SHORT RADIUS LONG TANGENT**




**SIZES: 14" thru 36"**

Developed for those installations that require an elbow with a short radius, yet this elbow provides all the additional advantages of Midwest "Long Tangents".

**4 SHORT RADIUS**

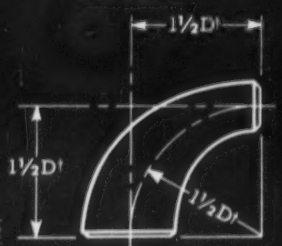



D-Nominal Pipe Size

**SIZES: 1" thru 36"**

Where space limitations prevent the use of Midwest "Long Tangent" or ASA long radius elbows, these short turn elbows without tangents are recommended.

**5 LONG RADIUS REDUCING**

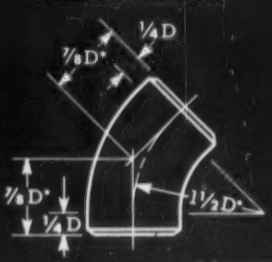



†-Larger Nominal Pipe Size

**SIZES: 2" thru 16"**

This elbow takes the place of two fittings . . . a straight elbow and a reducer, thus saving space and one weld. Only Midwest makes the reducing elbow in this size range.

**6 LONG RADIUS LONG TANGENT**



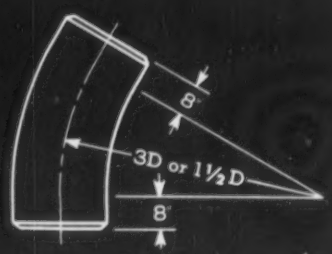

**7 LONG RADIUS ASA TYPE**

*-Approximate Value

**SIZES: 2" thru 30"**

The Midwest "Long Tangent" type is also available in 45° elbows at no increase in price. These tangents simplify the assembly of fitting to pipe or flange.

**8 CONTUR-ELLS**




**SIZES: ¾" thru 36"**

Like all Midwest Elbows, these 45° elbows are selectively reinforced to compensate for the higher stresses that occur in the throat of all elbows subjected to internal pressure.

**SIZES: 22" thru 30"**

Primarily designed for the gas transmission industry, these are available in small angles, with 8" tangents on both ends, and in carbon steel or high-yield steels.

Exceptional latitude in piping design and economy in erection . . . that's why the unequalled variety of Midwest Elbows is becoming increasingly popular. For example, the Midwest "Long Tangent" Elbow saves pipe . . . permits faster, easier, more accurate lining up . . . often eliminates a short nipple and its extra weld . . . costs no more than other elbows. For all the advantages to be gained by specifying Midwest Elbows, see Catalog 54; ask our distributor for a copy or we shall be glad to send it to you.

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pany, a New York distributor of fuel oils, expects to start construction as soon as its plans are approved by city authorities. The Paragon refinery will cost about $3B million to build.

At Providence, Commercial Oil Refining will install five catalytic processes—cracking, reforming, alkylation, polymerization and hydrotreating. The refinery's combination atmospheric- and vacuum-crude unit will be built to take a daily charge of 40,000 barrels, and its catalytic crackers will be rated for a total reactor charge of 25,000 barrels a day.

The Lummus Company is designing the Commercial Oil refinery, and J. F. Pritchard and Company is doing the initial design studies for the refinery at Tiverton.

**B. F. Goodrich, Canada, Ltd.,** has awarded the contract for construction of a new $3,500,000 chemical plant near Niagara Falls, N. Y. The plant, to produce geon polyvinyl materials, will be built by Arthur G. McKee & Company of Canada, Ltd. Construction will start early in 1956, with completion expected by early 1957.

**Texas Asphalt & Refining Company** plans to build a 2500-barrel-a-day asphalt refinery at Pasadena, Texas. The new facilities, expected to cost more than $1 million, are due to be completed in the second quarter of 1956.

**Esso Standard, S. A. F.,** has plans for installing a second catalytic-cracking unit at its Port Jerome, France, refinery. The unit, to be built for a daily capacity of 10,000 barrels, is expected to cost a little more than $11 million. The unit will go on stream early in 1957.

**Assam Oil Company, Ltd.,** will build a refinery in India if further crude resources are discovered in upper Assam. The company, making a survey to determine the extent of resources available in that region, would use the plant to complement operations at its Digboi refinery.

Another refinery being discussed for India would be built at Bhavnagar, on the Gulf of Cambay. Plans for the refinery, expected to cost more than $31 million, have been completed between the government of Saurashtra state and sponsors of the project, reported to be French.

**The Texas Company,** during 1956, will install a new 80,000-barrel-a-day crude unit at its Port Arthur, Texas, refinery. The plant, with a present capacity of 210,000 barrels a day, will also receive additional catalytic-cracking facilities.

These projects will be part of a program calling from capital expenditures of more than $1.5 billion in 1956. This figure, which covers all the company's wholly-owned operations, does not include spending through companies in which Texaco has a 50-percent interest or less.

Other construction to be taken up during the year will include a 180-ton-a-day anhydrous-ammonia plant at the Lockport, Ill., refinery. And the company will build facilities at its Beacon, N. Y., laboratories for expanded nuclear research.

**Malco Refineries, Inc.,** considering the sale of its Prewitt, N. M., refinery to El Paso Natural Gas Company (see **What's Happening**), is planning an expansion of its refining facilities at Artesia, N. M. Capacity of the Artesia plant would be increased from its present 10,000-barrel-a-day capacity, to take up some of the loss in refining capacity.

**Richmond Exploration Company,** a Standard Oil Company (New Jersey) subsidiary, is putting up a new asphalt plant in Venezuela. At Maracaibo, the $4-million installation will be built for a daily capacity of 10,000 barrels.

**Leonard Refineries, Inc.,** is increasing the crude oil capacity of its Alma, Mich., refinery to 14,000 barrels a day. In addition, the company is installing a 3500-barrel-a-day Ultraformer and a 5200-barrel-a-day Hydrofiner, together with sulphur-recovery equipment.

**E. I. du Pont de Nemours & Company** is planning to expand its polyvinyl-acetate-emulsion facilities at Niagara Falls, N. Y. The project, to cost $550,000, will be completed late in 1956.

**Borden Company** has plans for building a formaldehyde plant in Seattle, Wash. Designed to produce 36 million pounds a year, the new plant will double the Borden's production of formaldehyde on the West Coast. It is due to begin operations late in 1956.

**Tennessee Gas Transmission Company** is planning a gas-separation plant for La Porte, Texas, near Houston. One of the plant's products would be butane, some of which could be used by Petro-Tex Chemical Corporation at its nearby butadiene plant. Petro-Tex, in which Tennessee Gas owns half interest, is expanding its butadiene facilities.

## Who's Building. . .

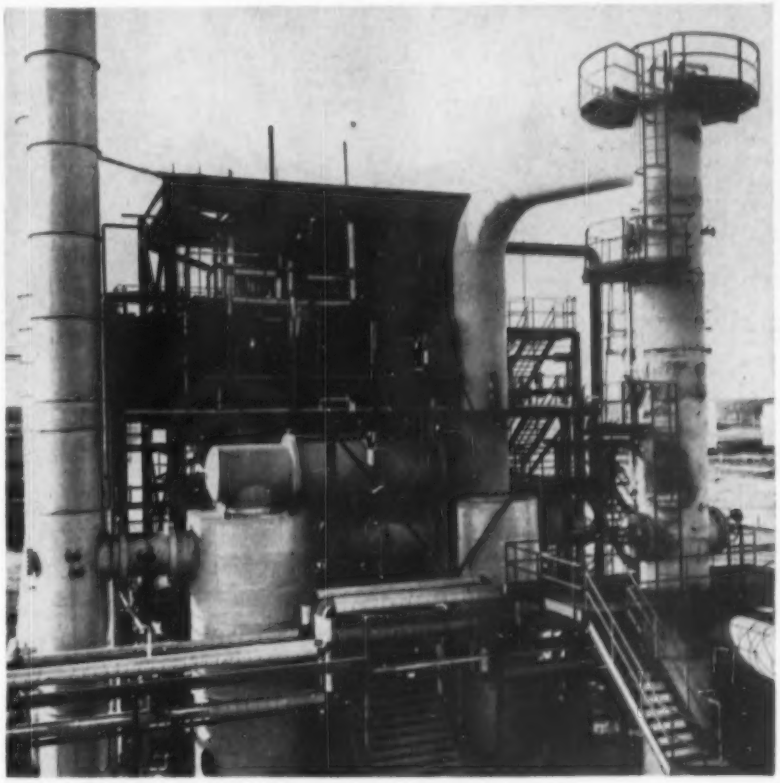
**The British Petroleum Company** is expanding its research and development facilities at Sunbury, England. The latest building to be completed is a laboratory for testing motor fuels. Equipment is now being installed, and the laboratory will be put in use during the next few months.

A features of the new facility is a chassis-dynamometer room. There, practically any road condition or temperature can be simulated, including winds up to 90 miles an hour, temperatures of 120 F., and humidity equivalent to that of the Persian Gulf.

**Queen City Oil & Refining Company** is planning to install a fluid catalytic cracking unit at its Dickinson, N. D., refinery. The unit, to be licensed by Universal Oil Products Company, is expected to be in operation by October 1956.

**Surpass Petro-Chemicals, Ltd.,** a subsidiary of Montgary Explorations, Ltd., is equipping a plant at Scarborough, Ont., to produce sulphonates and synthetic sulphonates for lubricants. The plant will go into operation sometime in 1956.

**Continental Oil Company** has awarded a contract for design and construction of a 1500-barrel-a-day catalytic-reforming unit at its Artesia, N. M., refinery. The contract went to Refinery Engineering Com-



**Canadian Unit on Stream—**

**The first of its kind in Canada, this carbon-monoxide boiler recently went into operation at the Sarnia, Ont., refinery of Canadian Oil Companies, Ltd., to help reduce air polluiton in the Sarnia area. Part of a $3-million expansion still underway there, the boiler combines the production of steam from waste heat and combustible gases with a reduction in air pollution. The steam will be needed to increase the refinery's daily capacity to 30,000 barrels a day. Construction and installation was directed by Combustion Engineering of Canada, Ltd. The new unit cost $500,000 to build.**

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## Who's Building. . .

pany. The unit, a Houdriformer, will be used to process straight-run naphthas to produce high-octane blending stock. The project is scheduled for completion early in 1956.

**Shell Chemical Corporation** will build a methyl-ethyl-keytone plant at Norco, La. Construction of the plant, which will have an annual capacity of 40 million pounds, will start immediately, with its completion scheduled for early 1957. This will be Shell's fourth such plant. The others are at Martinez and Dominguez, Calif., and at Houston.

**Phillips Petroleum Company** will store ethylene and butane in underground caverns near its Sweeny, Texas, refinery. Plans, approved by the Texas Railroad Commission, call for two 200,000-barrel reservoirs in Brazoria County's Clemens salt dome. The company's ethylene plant, now under construction at Sweeny, will be used to supply the polyethylene facilities it is building at Pasadena, Texas.

**X-L Refineries** has completed a new 2000-barrel-a-day refinery at Dawson Creek, B. C. The company, a division of Excelsior Refineries, Ltd., will process Peace River crudes, turning out gasoline, diesel and jet fuels, heating oils and heavy residual fuel oil. Construction costs ran an estimated $2 million.

**Dow Chemical Company** has selected Ironton, Ohio, as the site for a new plastics plant. The plant will be completed by fall 1956.

**General Tire & Rubber Company,** with El Paso Natural Gas Company and its associates, plans to build integrated synthetic-rubber-producing facilities at Odessa, Texas. The cost will run some $28 million.

General Tire will build a copolymer plant with an annual capacity of 40,000 tons of general-purpose synthetic rubber. Raw materials for the plant will be supplied from butadiene- and styrene-producing facilities to be built by El Paso Natural Gas and Odessa Natural Gasoline Company.

Construction will start immediately, with production of synthetic rubber scheduled to start in July 1957. The butadiene and styrene facilities will cost about $20 million, while the copolymer plant will take an outlay of about $8 million.

The integrated synthetic-rubber operation will be the first built since World War II and the first to be privately-financed.

This will be El Paso's first venture into the petrochemical field. The company, a large pipe-line concern, recently acquired refining facilities in New Mexico. (See **What's Happening.**)

General Tire had operated a government-built synthetic-rubber plant at Baytown, Texas, but its bid for the plant was rejected as too low. The present synthetic-rubber capacity of the U. S. is about 850,000 tons a year.

**Esso Petroleum Company, Ltd.,** will expand facilities of its relatively-new Fawley refinery near Southampton, England. Other Standard Oil Company (New Jersey) affiliates in Europe also are considering refinery-expansion projects.

One of these companies is S/A Norsk Esso, negotiating with the Norwegian gov-

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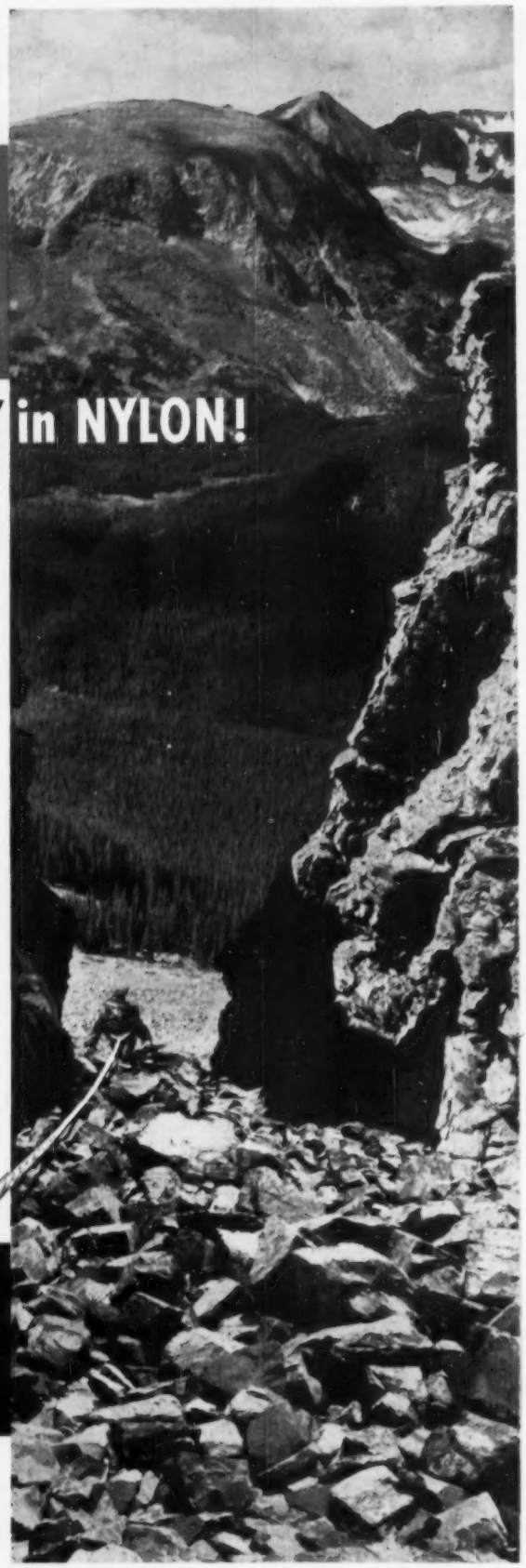

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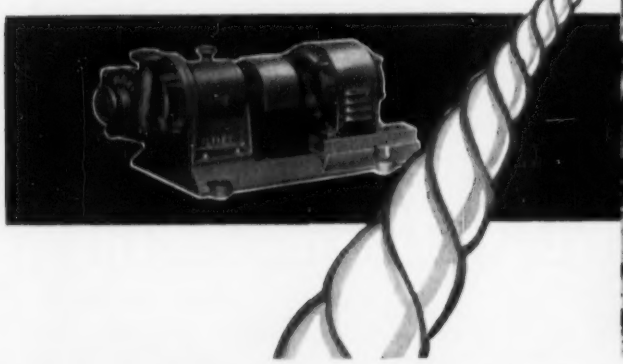

## Who's Building. . .

ernment about construction of a new refinery. The plant, probably to be on Oslo Fjord near Halden, would have a daily capacity of 30,000 barrels. The company now operates a 2000-barrel-a-day plant at Vallo.

**The Shell Company of the Philippine Islands, Ltd.,** plans to erect an oil refinery at Manila. Although no details were available on the size of the plant or the capital involved, it is expected to be the largest single postwar investment in the Philippines by a non-American enterprise. The British concern has started negotiations with the Philippine government on the project.

American Caltex Oil Company established the first big refinery in the Philippines about a year ago. Another U. S. firm, Standard-Vacuum Oil Company, is negotiating with the Philippine government for construction of a refinery.

The Shell project is subject to approval of the United Kingdom treasury, as is customary where investments of British capital are involved.

**American Gilsonite Company** has awarded another contract for construction of equipment at its proposed Grand Junction, Colo., refinery. The contract to install the refinery's catalytic reformer and hydrogen plant went to H. K. Ferguson Company.

The $10-million refinery will produce high-test gasoline and metallurgical coke from Gilsonite, a solid-hydrocarbon the company mines at Bonanza, Utah. The mineral will be transported in suspension by pipe line to Grand Junction.

Earlier, Foster Wheeler Corporation was named to construct the plant's delayed-coking unit, and Kaiser Engineers was picked to design and erect the calcining plant, utilities and auxiliary facilities. Petrocarb Equipment, Inc., will handle consulting engineering concerned with the calcining operation.

**International Refineries, Inc.,** has scheduled a $1,500,000 expansion program for its Wrenshall, Minn., refinery. Construction, to be started immediately, will be handled by The Ralph M. Parsons Company. The project is expected to increase the gasoline-producing capacity of the 10,000-barrel-a-day refinery.

**U. S. Oil & Refining Company** is preparing the site for construction of a 15,000-barrel-a-day refinery at Tacoma, Wash. The plant, to be the state's third new refinery in two years, will produce gasoline, diesel, stove and fuel oils and aviation fuels.

The other new refineries in Washington were built for Shell Oil Company at Anacortes and for General Petroleum Corporation at Ferndale. In addition, Standard Oil Company of California has bought a 2000-acre site for a refinery near Seattle, and The Texas Company is considering a refinery in the Pacific Northwest.

**Syrian Government,** which has been wanting a refinery for the past year, now is considering a Russian offer to build a plant. Earlier, the government had studied a proposal that Iraq Petroleum Company, Ltd., be called upon to build a refinery for the country.

According to reports, Russia is ready to build Syria a refinery any place the gov-


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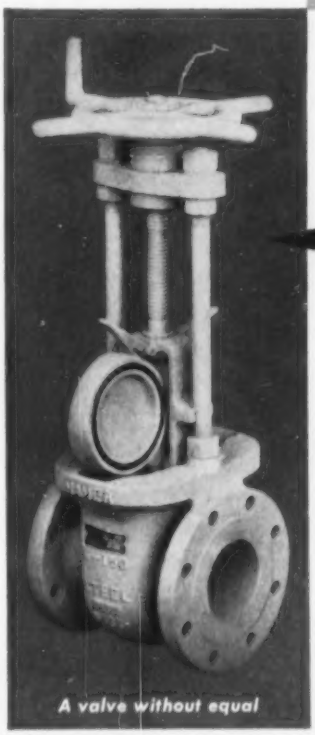


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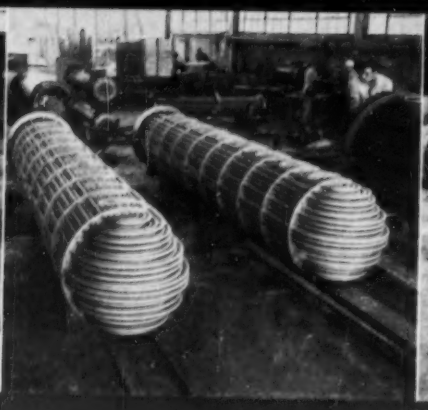

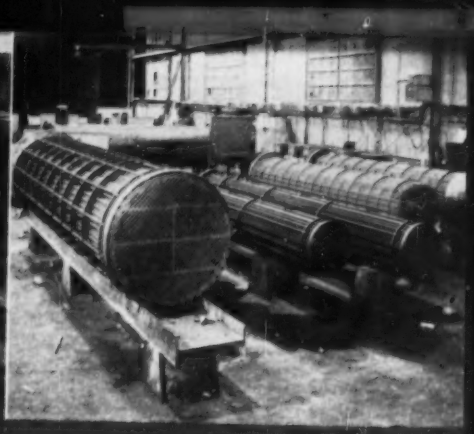

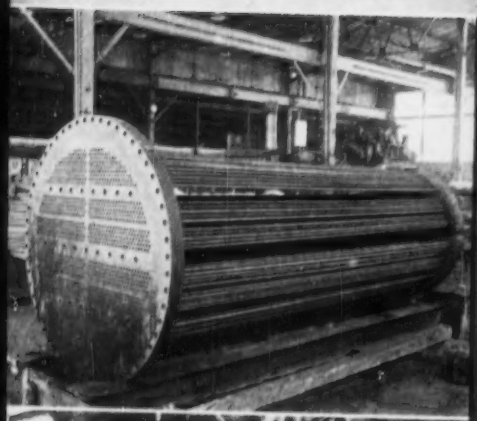

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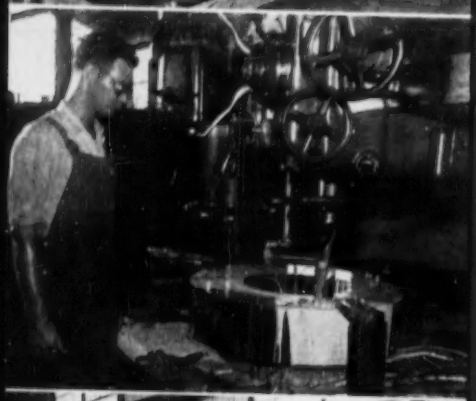

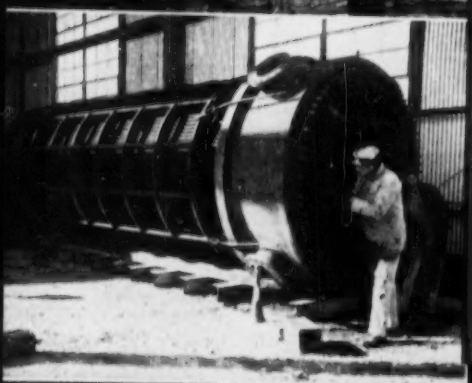

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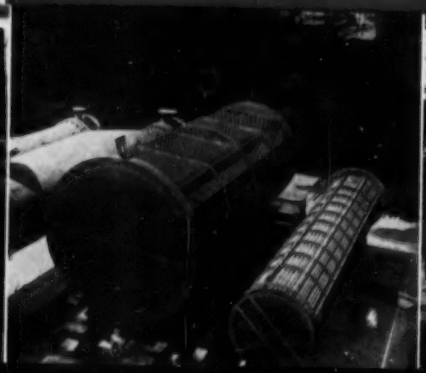

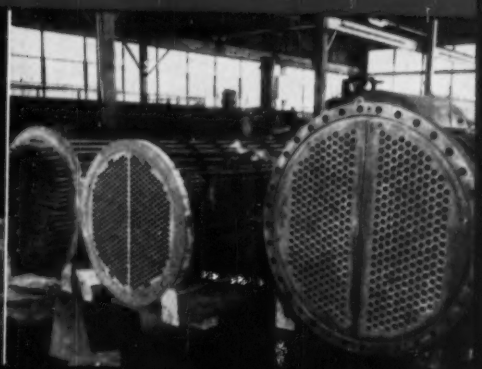

ernment wants it. Financial arrangements were not known, but it was understood that the Russian price would be very low.

The Syrian parliament has ratified an $18-million contract with Iraq Petroleum for use of a 555-mile pipe line through the country. Under the agreement, the oil company is pledged to furnish Syria about 600,000 tons of crude a year.

The government's earlier proposal had been that the company build a refinery at Banias for Syria's account, out of revenue the government receives from the pipe line operation.

**Cie. de Combustiveis de Lobito** is negotiating with the Portuguese government to build a refinery in Angola, West Africa. The government has indicated it would approve plans for a 10,000-barrel-a-day refinery. Construction of a plant this size would take about two years. The company is a subsidiary of Cie. Financiere Belge de Petroles, S. A.

**The Texas Company** has awarded the contract for engineering and construction of two new processing units at its Eagle Point Works in Westville, N. J. The units, a hydrotreater and a viscosity-breaker, will be built by Refinery Engineering Company. Both are scheduled for completion in 1956.

The hydrotreater is being designed to treat cracked distillates from the refinery's fluid catalytic-cracking unit, using hydrogen produced by the plant's existing Platformer. The viscosity breaker will process vacuum residuum, to turn out a high-quality fuel oil with a controlled viscosity. Pilot plant runs are being made by Treco to provide a basis for the unit's process design.

**The Dow Chemical Company,** with an Indian concern, has formed a new company to produce polystyrene in India. The new company will build a plant near Bombay designed to turn out some 27,000 tons of the plastic material a year. Dow's partner in the venture is Kilachand, Devchand and Company, Ltd., an Indian mercantile firm. The plant will be the first of its kind in south and southwest Asia.

**Texas-U. S. Chemical Company** has awarded the contract for expansion of its Port Neches, Texas, synthetic-rubber plant. The project, to increase capacity by 35 percent, will be handled by Tellepsen Petro-Chem Constructors. The plant's production will be increased to about 305 million pounds a year. Included in the expansion will be the conversion of one of the plant's two 30,000-ton units from the batch process to a continuous operation.

**Petroleum Chemicals, Inc.,** is planning a $4,350,000 expansion of its Lake Charles, La., butadiene facilities. Capacity of the plant, now 63,000 tons a year, will be increased to 79,000 tons. Work on the project, under a contract to The Fluor Corporation, Ltd., will be started soon and is scheduled for completion by fall 1956.

Petroleum Chemicals is owned jointly by Continental Oil Company and Cities Service Company. Organized in 1954, it purchased the butadiene plant early in 1955 from the government's Rubber Facilities Disposal Commission for about $17,500,000.

The butadiene plant is adjacent to the Cities Service refinery and to a synthetic-rubber plant owned by Firestone Tire & Rubber Company. Firestone is expected to build a new butadiene plant in the Lake Charles area.

**Air Reduction Company** will build a new oxygen plant at Calvert City, Ky. The plant, which will also produce nitrogen and argon, is scheduled for completion during the first half of 1956. Another Air Reduction plant, also due to be completed at Calvert City in 1956, will manufacture vinyl acetate monomer.

**U. S. Industrial Chemicals Company,** planning the world's first plant for the production of isomers of sebacic acid, excepts to bring the new facility into production early in 1957. Located at Tuscola, Ill., the new plant will use hydrocarbons from nearby Petro-Chemicals Corporation facilities and sulfuric acid and other raw materials from an adjacent U. S. I. installation. It will start with an initial production of 10 million pounds a year. The company is a division of National Distillers Products Corporation.

## Who's Building...

**Cities Service Company** is planning to build a new products-research center at Cranbury, N. J. The laboratory will concentrate on new-product development in fuels and lubricants. Plants call for facilities to accommodate some 150 scientists and technicians.

The equipment will include facilities to study the use of nuclear energy and radioactive-tracer techniques in improving petroleum products. The new laboratory is expected to be completed by early fall 1956.

**Arabian American Oil Company** has gone on stream with a new 12,500-barrel-a-day fluid Hydroformer at its Ras Tanura refinery. The new reformer, a $10-million unit, was engineered and installed


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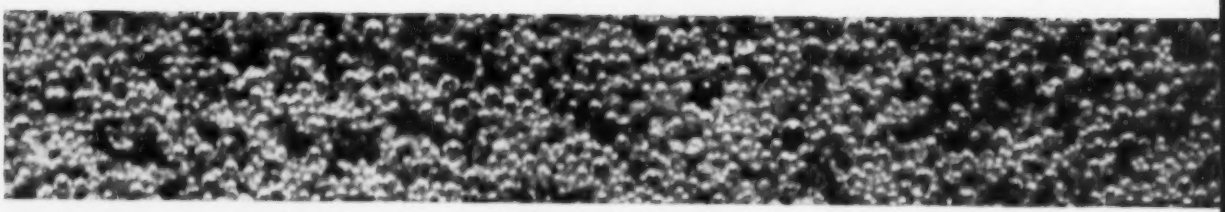

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by Britain's Lummus Company, Ltd. The main vessel, a 235-ton reactor, was fabricated in the Netherlands.

**Commonwealth Oil Refining Company,** nearing completion on its 25,000-barrel-a-day Puerto Rican refinery at Guayanilla Bay, is already putting some process equipment on stream. The plant, engineered and constructed by The Lummus Company, was to have cost some $25 million. The new facilities include a Houdriflow catalytic cracker and a Houdriformer.

**Pennsylvania Salt Manufacturing Company** is building a new organic-fluorine plant at Calvert City, Ky. The plant, expected to go into operation in 1956, will be a component of Pennsalt's integrated chlorine-fluorine operations on the Tennessee River.

**Esso Standard Oil Company** has a new plant, for the recovery of ethylene, scheduled for construction at its Linden, N. J., refinery. The equipment will be the first on the East Coast to supply concentrated ethylene.

## Who's Building . . .

**Midland Co-Operatives, Inc.,** will add a platinum-catalyst reformer to increase the high-octane-gasoline output of its Cushing, Okla., refinery. Also included in a $750,000 expansion program scheduled for the 12,000-barrel-a-day refinery will be additional tankage and a new desalting unit. The plant's reformer alone is expected to cost $600,000. The new equipment will be installed by April 1956.

# Construction Boxscore: Refineries and Other Plants . . .

| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| **EAST** | | | | | | | | | |
| *Air Reduction | Calvert City, Ky. | Oxygen Plt. | | | Under Constr. | Spring, 1956 | | | |
| | | Vinyl Acetate, Monomer Plt. | | | Under Constr. | Spring, 1956 | | | |
| Allied Chemical & Dye Corp. | Moundsville, W. Va. | Hydrogen & Carbon Monoxide Plt. | | | Completing | | | Girdler | Girdler |
| Ashland Oil & Refining Co. | Catlettsburg, Ky. | Add Crude Unit | 1600 bbls. | | Under Constr. | Early 1956 | | | |
| | | Cat. Cracker | 32,000 bbls. | | Planning | Early 1956 | | | |
| American Oil Co. | Yorktown, Va. | Refinery | 35,000 bbls. | $25,000,000 | Under Constr. | Late, 1956 | | Kellogg, Lummus, Parsons | Kellogg, Lummus, Parsons |
| Atlantic Refining | Philadelphia | Jet-fuel Blending | | $450,000 | ODM Approved | | | | |
| Commerce Oil Ref. | Portsmouth, R.I. | Refinery, | 30,000 bbls. | $30,000,000 | Planning | Early, 1957 | | Lummus | |
| | | Cat. Cracking | 25,000 bbls. | | | | | | |
| | | Crude Units | 40,000 bbls. | | | | | | |
| Cons. Chem Ind. | Le Moyne, Ala | Sulfuric Acid Plt. | | $2,000,000 | | Mid 1956 | | | |
| Du Pont | Parlin, N.J. | Polyester Film Base | | | | | | | |
| Du Pont | Parkersburg, W. Va. | Tetrafluoro-ethylene Expan. | | | | | | | |
| Du Pont | Niagara Falls, N.Y. | Adiponitrile Unit Expans. | | | | | | | |
| *Du Pont | Niagara Falls | Increase Poly-vinyl Acetate Cap. | | $550,000 | Planning | Late 1956 | | | |
| Escambia Bay Chemical Corp. | Pensacola, Fla. | Ammonia, Nitrogenous Fertilizer Plt. | | $25,000,000 | Under Constr. | Early 1956 | | | Chemico |
| Esso Standard Oil Co. | Linden, N.J. | Convert Blending Syst. to Semi-Automatic | | $2,120,000 | Under Constr. | 1st Qtr., 1956 | Esso R&E | Esso R&E | Staff |
| Esso Standard | Linden, N. J. | Fluid Hydro-former | 20,000 bbls. | | Planning | 3rd Qtr. 1956 | Esso R&E | | |
| *Esso Standard | Linden, N.J. | Ethylene Plt. | | | Planning | | | | |
| Esso Standard | Bayonne, N.J. | Add. Dewaxing Capacity | | | Engineering | 1st Qtr., 1956 | | Esso R&E | |
| Esso Standard Oil Co. | Everett, Mass. | Desaliters | 25,000 bbls. | $612,000 | Completing | | | Esso R&E | Petrolite |
| B. F. Goodrich | Louisville, Ky. | Syn. Rubber | | $2,500,000 | Under Constr. | 1st Qtr., 1956 | | Staff, Girdler | Girdler |
| Gulf Oil | Philadelphia | Gulfining | | | Building | | Gulf | Gulf, Kellogg | Kellogg |
| *Hercules Powder | Parlin, N.J. | Polyethylene | 30,000,000 lbs./yr. | $10,000,000 | Under Constr. | | | | |
| Kentucky Hydro-carbon | Maytown, Ky. | Ethane Plt. | 50 Mmcf | | Designing | Early 1957 | | | |
| Ketrona Chemical | Tarrant, Ala. | Ammonia Nitrate of Ammonia Plt. | | | Planning | 1956 | | Fluor | Fluor |
| Miami Oil & Refining Co. | West Palm Beach, Fla. | Refinery | 15,000 bbls. | $12,000,000 | Planning | | | | |
| Monsanto Chemical | Springfield, Mass. | Polyvinyl Chloride Resins Plt. | 26,000,000 lbs./yr. | $2,040,000 | Planning | 1st Qtr., 1956 | | Staff | |
| | | Nitric Acid Plt. | 60 ton/yr. | | Planning | 1956 | | Fluor | Fluor |
| Northern Chemical Industries | Searsport, Me. | Ammonia | 125 tons | | Under Constr. | 2nd Qtr., 1956 | Texaco | Girdler | Girdler |
| | | Nitric Acid | 60 tons | $9,000,000 | Under Constr. | | Du Pont | Girdler | Girdler |
| | | Nitrogen | | | Under Constr. | | | Girdler | Girdler |
| Northern Chemical | Searsport, Me. | Sulfuric Acid Plt. | 100 tons | | Planning | Jan., 1956 | | | |
| *Pennsalt | Calvert City, Ky. | Organic-Fluorine | | | Planning | 1956 | | | |
| The Penzoil Co. | Rouseville, Pa. | Platformer-Unifining | | | Considering | | U.O.P. | | |
| Pontiac Eastern Corp. | Hattiesburg, Miss. | Refinery | 12,000 bbls. | $18,000,000 | Planning | | U.O.P. | Fluor | Fluor |
| Procter & Gamble Mfg. Co. | Chicago, Ill. | Hydrogen Plt. | | | Under Constr. | May, 1956 | | Girdler | Girdler |
| *Reichhold Chemical | Tuscaloosa, Ala. | Sulfuric Acid Plt. | 100 tons/day | $1,000,000 | Planning | | | | |
| Seminole Oil | Fort Pierce, Fla. | Refinery | 15,000 bbls. | $16,000,000 | Planning | Aug., 1956 | U.O.P. | Blasco | |
| Sinclair Refining Co. | MarcusHook, Pa. | Crude Stills | 120,000 gals. | $12,700,000 | Under Constr. | May, 1956 | | Parsons | Parsons |
| Sinclair Refining | Marcus Hook, Pa. | Desulfurization | 10,000 bbls. | $3,800,000 | Under Constr. | Jan., 1956 | | Parsons | Parsons |
| Socony-Mobil | Paulsboro, N.J. | Sovaformer | 20,000 bbls. | | Under Constr. | March, 1956 | | Fluor | Fluor |
| Socony Mobil | Brooklyn | Sovaformer | | | Engineering | Oct. 1956 | | Bechtel | Bechtel |
| Socony Mobil | Buffalo, N. Y. | Gaso. Trtg. | | | Complete | | | Badger | Badger |
| Socony Mobil | Buffalo, N. Y. | Sovaformer | 9,000 bbls. | | Under Constr. | May, 1956 | | McKee | McKee |
| Southern Nitrogen | Savannah, Ga. | Ammonia Plt. | 250 ton | $14,000,000 | Under Constr. | Late 1956 | | Girdler | Girdler |
| Spencer Chemical | Vicksburg, Miss. | Addi. Nitrogen | | $1,500,000 | Under Constr. | Early, 1956 | | Staff | Quaker |

## REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| *Stauffer Chemical | Louisville, Ky. | Carbon Tetrachloride, Chloroform, Methylene Chloride, Hydrogen Chloride | ..... | ..... | Under Constr. | 1957 | ..... | ..... | ..... |
| Stauffer Chemical | Mobile, Ala. | Carbon Bisulfide Plt. | ..... | ..... | Planning | Spring, 1956 | ..... | ..... | ..... |
| Sun Oil Co. | Marcus Hook, Pa | Ammonia Plt. | 300 tons | $9,000,000 | Complete | ..... | ..... | Cat. Constr. | Cat. Constr. |
| Tennessee Eastman | Kingsport, Tenn. | Hydrogen Plt. | ..... | ..... | Under Constr. | Early 1956 | ..... | Girdler | Bay Min., Staff |
| *The Texas Co. | Westville, N.J. | Hydrotreater | ..... | ..... | Planning | 1956 | ..... | Treco | Treco |
| Thompson Chem. | North Dighton, Mass | Polyvinyl Chloride Plt. | ..... | ..... | Planning | ..... | SDC | SDC | ..... |
| Tide Water Associated Oil | Wilmington, Del | Refinery | 130,000 bbls. | $100,000,000 | Under Constr. | End, 1956 | ..... | Braun, Kellogg | ..... |
| **MID-CONTINENT** | | | | | | | | | |
| Ashland O&R | Findlay, Ohio | Reformer | 3000 bbls. | ..... | Planning | Early 1956 | ..... | ..... | ..... |
| | | Hydrogenation | 4000 bbls. | ..... | Planning | Early 1956 | ..... | ..... | ..... |
| Atlas Powder Co. | Site Undetermined | Ammonia Plt. | ..... | $6,750,000 | ODM Certified | ..... | ..... | ..... | ..... |
| Atlas Powder Co. | Site Undetermined | Glycerin Plt. | ..... | $5,940,000 | ODM Certified | ..... | ..... | ..... | ..... |
| Aurora Gasoline | Detroit | Reformer | 5500 bbls. | Part of | Under Constr. | Early 1956 | UOP | UOP | Staff |
| | | Unifiner | 7500 bbls. | $5,000,000 Project | Under Constr. | Late 1955 | UOP | UOP | Parsons |
| Calumet Nitrogen Products Co | Hammond, Ind. | Ammonia Nitrogen Fertilizer | 300 Tons | ..... | Under Constr. | May, 1956 | ..... | Fluor | Fluor |
| Champlin Refining Co. | Enid, Okla. | Fluid Cat. Crker. | 9,000 bbls. | ..... | Complete | ..... | Kellogg | ..... | Kellogg |
| Cities Service | Ponca City, Okla. | Reformer | 6,000 bbls. | ..... | Engineering | Jan., 1957 | UOP | UOP | Procon |
| Cities Service | Wichita, Kans. | Revamp Gaso. Plt. | ..... | ..... | ..... | Spring, 1956 | ..... | ..... | ..... |
| Cities Service Oil | Ponca City, Okla. | Increase Ref. | 10,000 bbls. | $2,000,000 | Engineering | ..... | ..... | ..... | ..... |
| Commercial Solvents Corp. | Peoria, Ill. | Enlarge Nitroparaffin Derivatives Fac. | ..... | Part of $5,000,000 | Planned | ..... | ..... | ..... | ..... |
| Cooperative Refinery | Coffeyville, Kans. | Platformer | 5000 bbls. | $250,000 | Under Constr. | March 1956 | UOP | SWECO | SWECO |
| | | Unifiner | 3000 bbls. | ..... | Under Constr. | March 1956 | UOP | SWECO | SWECO |
| | | Delayed Coker | 7000 bbls. | ..... | Under Constr. | Mid 1956 | UOP | ..... | ..... |
| Continental Oil | Ponca City | Dairy-Wax Plt. | 11,000,000 lbs./yr | $500,000 | Planning | Early, 1956 | ..... | ..... | ..... |
| Derby Oil | Wichita, Kans. | Ultraformer | 2500 bbls. | Part of $700,000 | Under Constr. | July, 1956 | Standard-Ind. | ..... | Pritchard |
| *Dow Chemical | Ironton, Ohio | Polystyrene Plt. | ..... | ..... | Under Constr. | Fall, 1956 | ..... | ..... | ..... |
| Du Pont | Montague, Mich. | Neoprene Plt. | ..... | ..... | Planned | 4th Qtr., 1956 | ..... | ..... | ..... |
| DX-Sunray | Duncan, Okla. | Expan. Cat. Cracking | 5000 bbls. | $250,000 | Planning | ..... | ..... | ..... | ..... |
| D-X Sunray | Tulsa | Delayed Coking | 7,000 bbls. | $2,500,000 | Complete | ..... | ..... | Kellogg | Kellogg |
| El Dorado Refining | El Dorado, Kan. | Cat. Reformer | 2,500 bbls. | ..... | Planning | ..... | U.O.P. | ..... | ..... |
| Firestone Tire | Akron, Ohio | Expand Syn. Rubber Plt. | 135 percent | ..... | Planning | ..... | ..... | ..... | ..... |
| Goodrich-Gulf | Avon Lake, Ohio | Synthetic Rubber Pilot Plt. | ..... | ..... | Planning | ..... | ..... | ..... | ..... |
| Hercules Powder | Louisiana, Mo. | Formaldehyde Plt. | 100,000,000 lbs. yr. | ..... | Under Constr. | Late 1956 | ..... | ..... | ..... |
| | | Pentaerythrytol Plt. | 24,000,000 lbs./yr. | ..... | Under Constr. | Late 1956 | ..... | ..... | ..... |
| International Refineries | Wrenchall, Minn | Petroleum Refining Fac. | ..... | $9,500,000 | ODM Approved | ..... | ..... | ..... | ..... |
| *Leonard Refineries | Alma, Mich. | Cap. Increase | 14,000 bbls. | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| Leonard Refineries | Alma, Mich. | Ultraformer | 3,000 bbls. | ..... | Under Constr. | ..... | ..... | Parsons | Parsons |
| | | Hydrofiner | 5,200 bbls. | ..... | Under Constr. | ..... | ..... | Pritchard | Pritchard |
| *Michigan Chemical | El Dorado, Ark. | Bromine Plt. | ..... | ..... | Planning | Fall, 1956 | ..... | ..... | ..... |
| Midland Co-op. | Cushing, Okla. | Platformer | 3000 bbls. | $650,000 | Under Constr. | April, 1956 | UOP | UOP | Procon |
| Naph-Sol Refining Co. | Muskegon, Mich | Cat. Reformer | 6,000 bbls. | ..... | Planned | ..... | ..... | ..... | ..... |
| National Co-operatives | McPherson, Kans | Alkylation | 1400 bbls. | ..... | Planning | ..... | UOP | ..... | ..... |
| Northwestern Refining | St. Paul Park, Minn. | Cat. Reformer | 6,000 bbls. | ..... | Planning | May, 1956 | ..... | ..... | ..... |
| Olin Mathieson | Olin, Ind. | Cellophane Plt. | ..... | ..... | ..... | 1956 | ..... | ..... | ..... |
| Pana Refining Co. | Pana, Ill. | Modernization | 11,600 bbls. | $900,000 | ..... | ..... | ..... | ..... | ..... |
| Pana Refining | Pana, Ill. | Girbotol Unit | ..... | ..... | Under Constr. | ..... | ..... | ..... | Parker |
| *Phillips Petroleum | Kansas City | Expan. Lube Plt. | 20 percent | ..... | Under Constr. | Fall 1956 | ..... | ..... | ..... |
| Phillips Petroleum | Kansas City, Kansas | Catalytic Reformer | 16,000 bbls. | $5,400,000 | Under Constr. | Spring, 1956 | U.O.P. | Procon Phillips | Procon |
| Phillips Petroleum & Magnolia Petro. | Lindsay, Okla. | Nat. Gasoline | ..... | ..... | Under Constr. | 1956 | ..... | Phillips | Phillips |
| Prime Oil Co. | Calumet City, Ill | Refinery | 15,000 bbls. | $10,000,000 | Planned | ..... | ..... | ..... | ..... |
| The Pure Oil Co. | Lemont, Ill. | Cat. Reformer | ..... | ..... | Planning | ..... | ..... | ..... | ..... |
| R&J O&R | Princeton, Ind. | Thermal Poly | 1800 bbls. | ..... | Planning | ..... | ..... | UOP | ..... |
| Sinclair Refining Co. | E. Chicago, Ind. | Cat. Cracking Expan | ..... | $3,252,000 | ODM Cert. | ..... | ..... | ..... | ..... |
| | | Crude Unit | ..... | ..... | Under Constr. | May, 1956 | ..... | ..... | ..... |
| Socony Mobil | E. Chicago, Ind. | Sovaformer | ..... | ..... | Under Constr. | Dec., 1956 | ..... | Braun | Braun |
| Socony Mobil | Trenton, Mich. | Sovaformer | ..... | ..... | Under Constr. | April, 1956 | ..... | Bechtel | Bechtel |
| Socony Mobil | East Chicago, Ind | Alkylation | ..... | ..... | Under Constr. | Feb., 1956 | ..... | Kellogg | Braun |
| | | Crude Unit | 30,000 bbls. | ..... | Under Constr. | May, 1956 | ..... | ..... | ..... |
| Standard-Indiana | Whiting, Ind. | Ultraformer | 14,000 bbls. | ..... | Under Constr. | April, 1956 | Standard-Ind. | Parsons | Parsons |
| Standard-Indiana | Wood River, Ill. | Coking Unit | 8,500 bbls. | ..... | Planning | 1957 | ..... | ..... | ..... |
| Standard-Indiana | Mandan, N. D. | Ultraformer | 5,400 bbls. | ..... | Engineering | Late 1956 | Standard-Ind. | ..... | Parsons |
| Standard-Indiana | Sugar Creek, Mo. | Ultraformer | 12,600 bbls. | ..... | Complete | ..... | Standard-Ind. | ..... | Parsons |
| Standard (Ohio) | Lima, Ohio | Petrochemical Plt: Anhydrous Ammonia | 300 tons | $17,000,000 | Complete | ..... | ..... | ..... | Kellogg |
| | | Nitric Acid | 180 tons | | | | | | |
| | | Nitrogen Solution | 200 tons | | | | | | |
| | | Offsite Fac. | ..... | ..... | ..... | ..... | ..... | ..... | McKee |
| | | Urea Plt. | 120 tons | ..... | Complete | ..... | Vulcan | Vulcan | Vulcan |
| Standard (Ohio) | Lima, Ohio | Dry-Ice Plt. | 100 tons | $800,000 | Under Constr. | April, 1956 | ..... | ..... | ..... |
| Standard (Ohio) | Cleveland, Ohio | Ultraformer | 11,000 bbls. | $4,400,000 | Under Constr. | 2nd Qtr., 1956 | Standard-Ind. | Fluor | Fluor |
| St. Paul Ammonia Products Co. | Pine Bend, Minn | Ammonia Plt. | 200 tons | $15,000,000 | Under Constr. | April, 1956 | Texaco | Lummus | Lummus |
| *Sun Oil | Toledo, Ohio | Alkylation | 1,600 bbls. | $1,200,000 | Under Constr. | April, 1956 | ..... | ..... | ..... |
| Sunray-Midcontinent | Moore, Okla | Exp. Gaso. Plt. | ..... | $275,000 | Under Constr. | May, 1956 | ..... | Staff | ..... |
| The Texas Co. | Lockport, Ill. | Alkylation Plt. | 1,000 bbls. | ..... | Under Constr. | 1st Qtr., 1956 | ..... | Staff | ..... |

* Construction Boxscore Continued on Page 217

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## REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| *U. S. C. I. | Tuscola, Ill. | Isomer of Sebracic Acid | 10,000,000 lb./yr. | | Under Constr. | | | | |
| Vickers Petroleum | Potwin, Kans. | Reformer | | | Planning | | | | |
| | | Cat. Poly | | | Planning | | | | |
| Wisconsin Oil Refining Co. | Sheboygan, Wis. | Vacuum Unit | 2,500 bbls. | | Planning | | | Koch | |
| **SOUTHWEST** | | | | | | | | | |
| American Republics Corp., et al | Silsbee, Texas | Gaso. Plt. | 20 Mmcf | $1,000,000 | Complete | | | Braun | Olsen |
| Arkansas Fuel Oil | Panola County, Texas | Cat. Reformer | 1,800 bbls. | | Engineering | | | | |
| Aviation Fuels | Beaumont, Tex. | Refinery | | $24,070,000 | | ODM Approved | | | |
| Bureau-Mines | Exell, Texas | Helium Plt. | | $6,000,000 | Planning | | | Stearns-Rogers Bureau-Mines | |
| Bay Petroleum | Chalmette, La. | Ref. Expan. | | $1,850,000 | Under Constr. | May, 1956 | UOP | | |
| Cities Service, et al | Seminole, Texas | Nat. Gas Plt. | 55,000 gals. | | Planning | 1956 | | | Delta |
| Cities Service et al | Midland, Texas | Nat. Gaso. Plt. | | | Engineering | | | | |
| Columbian Carbon Co. | North Bend, La | Carbon Black Plt | 60,000,000 lbs./yr. | | Complete | | | | |
| Cosden Pet. | Big Spring, Tex. | Reformer | 3900 bbls. | $2,500,000 | Under Constr. | May, 1956 | UOP | Procon | Procon |
| | | Revamp Cat. Cracker | 13,000 bbls. | $1,000,000 | Under Constr. | Jan., 1957 | UOP | Cosden | Cosden |
| | | Unifiner | 2100 bbls. | $137,000 | Complete | | UOP | Cosden | Cosden |
| | | Styrene Plt. | | $2,900,000 | Planning | Fall, 1956 | | Badger | Badger |
| Corpus Christi Refining Co. | Tucker, Texas | Modernization | | | Planned | | | | |
| Eastern States Petroleum Co. | Houston, Texas | Coking Plt. | 13,000 bbls. | $4,000,000 | Projected | | | | |
| El Paso Natural Gas. | Odessa, Texas | Butadiene, Styrene Plts. | | $20,000,000 | Planning | July, 1957 | | | |
| D. D. Feldman Co. | Lake Arthur, La. | Petrochem. Plt. | | $843,000 | Applied for certificate of necessity | | | | |
| Firestone Tire | Lake Charles, La. | Expand Synth. Rubber Plt. | †150,000 ton/yr. | | | | | | |
| General Tire | Odessa, Texas | Copolymer Plt. | 40,000 ton/yr. | $8,000,000 | Planning | July, 1957 | | | |
| Goodyear Synthetic Rubber | Houston | Copolymer Expansion | †50% | $750,000 | Planning | | | | |
| Gulf Oil | Port Arthur, Texas | Two Gulfiners | 20,000 bbls. Each | | Under Constr. | | Gulf | Gulf, Kellogg | Kellogg |
| Gulf Oil | Pt. Arthur, Tex. | Inc. Ethylene Fac. | | | Considering | | | | |
| Gulf Oil | Port Arthur Texas | Crude Topping | 109,000 bbls. | | Under Constr. | Spring, 1956 | | McKee-Gulf | McKee |
| | | Catalytic Cracking Unit | 68,500 bbls. | | Under Constr. | Spring, 1956 | | Kellogg | Kellogg |
| Humble | Ironton, Texas | Gasoline Plt. | 11 Mmcf | | Complete | | | | |
| Ingram Oil & Ref. | Meraux, La. | Cat Reformer | | | | | | | |
| | | Refractionation | | $1,000,000 | Under Constr. | April, 1956 | U.O.P. | SWECO | SWECO |
| | | Gaso. Stab. | 3,000 bbls. | | | | | | |
| Jefferson Lake Sulphur | Bayou Sale, La. | Gasoline Plt. | 40 Mmcf | | Complete | | Jefferson Lake | Fish | Fish |
| Magnolia | Beaumont, Tex. | TCC Unit | 2800 bbls. | | | | | | |
| | | Sovaformer | 20,000 bbls. | $25,000,000 | | Fall, 1956 | | | |
| | | Vacuum Flash Tower | | | | | | | |
| McBride Refining Co | Port Brownsville, Texas | Ref. Expan. | †2,500 bbls. | $2,500,000 | Planned | | | | |
| MidSouth Chemical | Lake Charles, La. | Ammonia Plt. | | | Planning | | | | |
| North American Petro. | Corpus Christi, Texas | Refinery | | $1,000,000 | Under Constr. | | | | |
| | | Cat. Reformer | 2,000 bbls. | | | | Atlantic | | |
| Northeast Texas Chemical Co. | East Texas | Chemical and Fertilizer Plt. | | | Planning | | | Tears | Beck |
| Petroleum Chemicals | Lake Charles, La. | Butadiene Plt., Expansion | †79,000 ton/yr. | | Planning | Fall, 1956 | | Fluor | Fluor |
| Petro-Tex Chemical | Houston | Butadiene Expansion | †45,000 tons/yr. | $1,000,000 | Under Constr. | Late 1956 | | Bechtel | Bechtel |
| Phillips Pet. | Sweeny, Texas | Nat. Gas. Liquid Fractionation | 30,000 bbls. | | Planning | Dec., 1956 | | | |
| | | H. F. Alkylation | 2,000 bbls. | | Planning | Dec., 1956 | | | |
| | | Gas Cracking Facilities | 5,500 bbls. | | Planning | Dec., 1956 | | | |
| Phillips Petroleum | Andrews, Texas | Nat. Gaso. Plt. | 75 Mmcf | | Under Constr. | Early 1956 | | Phillips | Phillips |
| Phillips Petroleum | Crane, Texas | Nat. Gaso. Plt. | | | Under Constr. | 1956 | | Phillips | Phillips |
| Phillips Chemical | Sweeny, Texas | Ethylene | 329,000 lbs. | $12,357,000 | Planning | Dec., 1956 | | | S&W, Badger Div. |
| Phillips Chemical | Pasadena, Texas | Polyethylene | 301,000 lbs. | $31,525,000 | Planning | Aug., 1956 | | Phillips | |
| Phillips Chem. | Phillips, Texas | Exp. Copolymer Plt. | | | Under Constr. | Sept., 1956 | | | |
| Premier Pet. Co. | Longview, Tex. | Cat. Poly. Plt. | | | Under Constr. | | | | |
| The Pure Oil Co. | Smith Bluffs, Texas | Cat. Reformer | 12,000 bbls. | | Under Constr. | Spring, 1956 | Standard-Ind. | Parsons | Parsons |
| The Pure Oil Co. | Smith Bluffs, Tex. | Feed Preparation | 20,000 bbls. | | Under Constr. | Spring, 1956 | Standard, Ind. | Parsons | Parsons |
| Shell Chemical | Norco, La. | Hydrogen Peroxide Offsite Facl. | | | Under Constr. | | | Braun, Fluor | Braun, Fluor |
| Shell Oil | Houston | Cat. Reformer | 16,000 bbls. | | Under Constr. | Early, 1956 | | Procon | Procon |
| | | Hydrodesulfurization Unit | 16,000 bbls. | | Under Constr. | | | | Procon |
| Shell Chemical | Houston | Bisphenol Expan. | | | Under Constr. | 1st Qtr., 1956 | | Lummus | Lummus |
| Sinclair Refining | Houston | $SO_3$ Sulfonation | | $2,200,000 | Under Constr. | Jan., 1956 | | Badger | Badger |
| Sinclair Refining | Houston, Texas | Cat. Reformer | 24,000 bbls. | $16,500,000 | Under Constr. | April, 1956 | Sinclair | Kellogg | Kellogg |
| Southwest Gas | Dulach, La. | Reforming Unit | 1,800 bbls. | $750,000 | Complete | | | | Fish |
| Southwestern Oil & Refining | Corpus Christi, Texas | Platformer | 9,000 bbls | $2,195,000 | Under Constr. | Feb., 1956 | | | Treco |
| Stanolind Oil & Gas Co. | Ector County, Texas | Gas Comp. | | $209,000 | ODM Cert. | | | | |
| Stanolind Oil & Gas | Brownsville, Texas | Recondition & Revamp | | | Under Constr. | Jan., 1956 | | Lummus | Lummus |
| Sunray Mid-Continent | Branch, La. | Cycling & Gaso. Plt. | 24 Mmcf | $1,500,000 | Complete | | | Tuloma | Tuloma |
| Sunray Mid-Continent | Ingleside, Texas | Nat. Gaso. Plt. | 140 Mmcf | $3,000,000 | Under Constr. | Feb., 1956 | | Dresser | Dresser |
| Suntide Refining Co. | Corpus Christi, Texas | Aliphatic Naphtha Solvent | 5000 bbls | | Planned | | | U.O.P. Staff | |
| *Texas Asphalt & Ref. | Pasadena, Tex. | Asphalt Ref. | 2,500 bbls. | $1,000,000 | Planning | 2nd Qtr., 1956 | | | |
| *Texas City Refining | Texas City, Tex. | Cat. Reformer | 6,000 bbls. | | Planning | | | | |
| Texas Butadiene & Chemical Corp. | Houston | Aviation Alkylate, Butylenes & Butadiene | | $26,000,000 | Planned | Late 1956 | Houdry | | Fluor |

## REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| Texas Eastman | Longview, Texas | Inc. Oxo Fac. | | | Planning | 1956 | | | |
| Texas Gulf Producing | Odessa, Texas | Exp. Gaso. Plt. | 135 Mmcf | $1,250,000 | Under Constr. | | | | Fish |
| **ROCKY MOUNTAIN** | | | | | | | | | |
| American Gilsonite | Fruita, Colo. | Gasoline from Gilsonite | 7000 bbls. | $10,000,000 | Under Constr. | Late 1956 | | | Foster, Wheeler Kaiser Eng., Ferguson |
| Atlantic Refining Co. | Lovington, N.M. | Natural Gas | 25 Mmcf. | | Projected | | | | |
| Big West Oil | Kevin, Mont. | Cat. Reformer | 1,000 bbls. | $500,000 | Complete | | U.O.P. | Procon | Procon |
| Carter Oil | Billings, Mont. | Hydroformer | 2500 bbls. | | Under Constr. | Jan., 1956 | Esso R&E | Fluor | Fluor |
| | | Hydrofiner | 6900 bbls. | | Under Constr. | Jan., 1956 | Esso R&E | Fluor | Fluor |
| Continental Oil | Billings, Mont. | Ref. Exp. | 8500 bbls. | $1,000,000 | Under Constr. | Jan., 1956 | Union | Staff | Stearns-Rogers |
| Continental Oil | Artesia, N. M. | Reformer | 1500 bbls. | $700,000 | Complete | | Houdry | Treco | Treco |
| Cullen Group | Newcastle, Wyo | Gas Plt. | | $4,500,000 | Planned | | | | |
| Famarian Oil & Refining Co. | Monument, N. M | Cat. Reforming Unit | 650 bbls. | $375,000 | Complete | | U.O.P. | U.O.P. | Famarian Oil & Refining Co. |
| Famarian, O&R | Monument, N. M. | Unifiner | 1,000 bbls. | $100,000 | Complete | | UOP | UOP | Staff |
| First National Petroleum Corp. | Jensen, Utah | Ref. Expan. | To 3,000 bbls. | | Planned | | | | |
| Frontier Refining Co. | Cheyenne, Wyo. | Ref. Expan. | 17,500 bbls. | $1,500,000 | Complete | | U.O.P. | U.O.P. | Procon |
| *Salt Lake Refining | Salt Lake City | Increase Cap. | 15,000 bbls. | | Under Constr. | March, 1956 | | | Staff |
| *Sioux Oil | Newcastle, Wyo | Cat. Reformer | 750 bbls. | | Under Constr. | | Houdry | Litwin | Litwin |
| Skelly Oil | Denver | Cat. Reformer | | | Under Constr. | | | | |
| Sooony Mobil | Casper, Wyo. | Thermal Crkg. | | | Engineering | June, 1956 | | Stearns-Rogers | Stearns-Rogers |
| Standard-Indiana | Casper, Wyo. | Heavy Oils, Mod. & Expan. | | | Planning | 1957 | | | |
| The Texas Co. | Casper, Wyo. | Cat. Reformer | 4,800 bbls. | | Engineering | 2nd Qtr., 1956 | U.O.P. | Fluor, U.O.P. | Fluor |
| Union Oil Co. (Calif.) | Rifle, Colo. | Shale Oil Pilot Plt. | | $5,000,000 | Under Constr. | | | Stearns-Rogers | |
| U. S. Steel Corp. | Geneva, Utah | Anhydrous Ammonia | 200 tons | $20,000,000 | Planned | 1956 | | Blaw-Knox | Blaw-Knox |
| Western States Refg. | Salt Lake City | Cat. Reformer | 1,000 bbls. | $300,000 | Under Constr. | | Houdry | | |
| **WEST COAST** | | | | | | | | | |
| Brea Chemicals, Inc. | Brea, Calif. | Nitric Acid & Ammonium Nitrate Plt. | 150 tons | $3,000,000 | Complete | | | C & I | C & I, Macco |
| California Stray Chemical | Richmond, Calif. | Fertilizer Plt. | | $3,000,000 | Under Constr. | Mid-1956 | | | |
| Caminol | Hanford, Calif. | Petroleum Refining Fac. | | $1,600,000 | ODM Approved | | | | |
| Carbide & Carbon Chemicals Company | Torrance, Calif. | Polyethylene Plt. | 60 million lbs./yr. | $36,000,000 | Complete | | | | |
| Columbia River Chemicals | Pasco, Wash. | Anhydrous Ammonia | 160 tons | $12,000,000 | Complete | | | Fluor | Fluor |
| | | Urea | 110 tons | | | | | | |
| | | Ammonium Sulfate | 140 tons | | | | | | |
| Consolidated Mining & Smelting | Portland, Ore. | Urea Plt. | 100 tons | | Planning | | | | |
| | | Ammonia Plt. | 200 tons | | Planning | | | | |
| Dow Chemical | Torrance, Calif. | Exp. Styrene Plt. | | | Completing | | | | |
| Du Pont | Antioch, Calif. | Fluorinated Hydrocarbons. Tetrethyl Lead | | | | 4th Qtr., 1956 | | | |
| Dupont | Antioch, Calif. | Sodium, Ethyl Chloride, Trichlorethyene, Perchorethylene | | | Planning | 1st Qtr., 1957 | | | |
| Fletcher Oil Co. | Wilmington, Calif. | Topping Unit | 10,000 bbls. | $976,000 | ODM Cert. | | | | |
| General Petroleum | Ferndale, Wash. | Refinery Expan. Pretreaters, Boilers, Soverformer | | $5,600,000 | Under Constr. | 1956 | | E & A | E & A |
| Golden Bear Oil | Bakersfield, Cal. | Vacuum Unit | 3500 bbls. | | Under Constr. | | | | |
| Hancock Oil Co. | Signal Hill Calif. | Fluid Coking Unit | 6,000 bbls. | $1,814,800 | ODM Certified | | | | |
| Hancock Oil Co. | Long Beach | Cat. Reformer | 2,500 bbls. | $550,000 | ODM Certified | | | | |
| *Kopper & Brea | West Coast | Polyethylene Plt. | 50,000,000 lbs./yr. | | Planning | 1957 | | | |
| Pacific Oil & Refining Co. | Tacoma, Wash. | Refinery | 10,000 bbls. | | Under Constr. | | | | |
| Phillips Pacific | Pasco, Wash. | Ammonia Plt. | 200 tons | $12,000,000 | Planning | Late 1956 | | Phillips Chem. | Fish |
| Richfield Oil | Watson, Calif. | Cat. Reformer | 17,000 bbls. | | Under Constr. | Mid-1956 | Sinclair-Bakers | Parsons-Staff | Parsons |
| Rothschild Oil | Santa Fe Springs, Calif. | Cat. Crker. | 6,000 bbls. | $2,000,000 | | | | | Braun |
| Shell Chemical | Ventura, Calif. | Urea Plt. | | | Engineering | Sept., 1956 | Montecatini | Kellogg | Kellogg |
| *Shell Chemical | Torrance, Calif. | Latex Fac. | | | Under Constr. | | | | |
| Standard (Calif.) | Richmond, Calif. | Ammonia Plt. | 300 tons | $12,800,000 | Engineering | Mid-1956 | | Kellogg | Kellogg |
| Standard (Calif.) | Richmond, Calif | Nitric Acid Plt. | 225 tons | | Planning | Mid-1956 | | C. & I. | |
| Standard (Calif.) | Richmond, Calif. | Isophthalic Plt. | 50 mln. lbs./yr. | $10,900,000 | Complete | | | Staff | Ferguson |
| Standard Oil (Calif.) | Honolulu | Refinery | 20-30,000 bbls. | $25-30,000,000 | Planned | Late 1957 | | | |
| Stauffer Chemical | Compton, Calif. | Sulfuric Acid | | $57,070 | Engineering | | | | |
| Stauffer Chemical | Richmond, Calif. | Sulfuric Acid | | $283,500 | | | | | |
| Sunset Oil Co. | Portland, Ore. | Refinery | 20,000 bbls. | | Considering | | | | |
| The Texas Co. | Pacific NW. | Refinery | | | Planning | | | | |
| The Texas Co. | Wilmington, Cal. | Deasphalter | 13,000 bbls. | | Under Constr. | 2nd Qtr., 1956 | | Texaco | Texaco |
| The Texas Co. | Wilmington, Calif. | Furfural Unit | 25,000 bbls. | | Under Constr. | 1st Qtr., 1956 | | Staff | Staff |
| Tide Water | Avon, Calif. | Fluid Coker | 42,000 bbls. | | Under Constr. | May, 1956 | | Bechtel | Bechtel |
| | | Hydrodesulfurizer | 24,000 bbls. | | Planning | Spring, 1956 | | | |
| | | Gas Plt. | | | Planning | Spring, 1956 | | | |
| | | Exp. Fluid Cat. Cracking | | | Planning | Spring, 1956 | | | |
| Union Oil (Calif.) | Los Angeles | Terminal; Lube Oil Blending | | $3,000,000 | Under Constr. | Jan., 1956 | | Bechtel | Bechtel |
| Union Oil (Calif.) | Edmonds, Wash | Two Asph. Stills | 100 tons | $400,000 | Under Constr. | Early 1956 | | E&A | |
| Union Oil (Calif.) | Oceano, Calif. | Sulphur Recova | 42 tons | | Under Constr. | Early 1956 | | Girdler | Bechtel |
| **OUTSIDE U.S.A. Canada** | | | | | | | | | |
| Anglo American Explorations | Hartell, Alta. | Cat. Reformer | 1000 bbls. | $300,000 | Completing | | Atlantic | Grebe-Doremus | Grebe-Doremus |
| Anglo-Canadian | Sarnia, Ont. | Ref. Exp | 25,000 bbls | | Under Constr | 1956 | | | |
| | | | 30,000 bbls. | | Under Constr. | 1957 | | | |
| British American Oil | Clarkson, Ont. | Cat. Reforming | | | Planning | | | | |

■ Construction Boxscore Continued on Page 221

FOSTER WHEELER ANNOUNCES A

# COMPLETELY NEW

## COOLING TOWER

...designed for FASTER ERECTION
and LONG-RANGE ECONOMY

*Here are some of its outstanding new features:*

**Water-Mizer Drift Eliminators,** assembled in racks, engineered for maximum efficiency. Drift losses held well *below* recommended minimum values.

**Full Cone Spray Nozzles** provide maximum dispersion with exceptionally low pressure drop. Spray pattern remains excellent for any overload and for at least 30% below design flow.

**3'x6' Double Diamond Fill Racks** utilize heavy stringers and 1" lath spaced in a diamond pattern, affording rigidity while minimizing pressure drop.

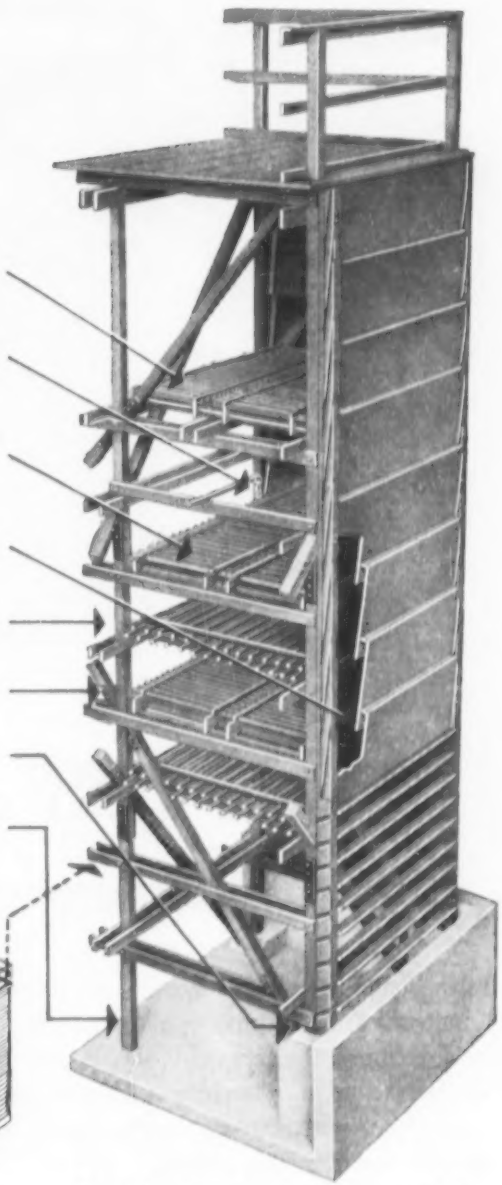
**Double Lapped Sheathing Panels** provide the water-tight advantage of double-wall construction yet avoid stagnant air spaces and prevent wood attack. Panels are pre-assembled to cut erection time.

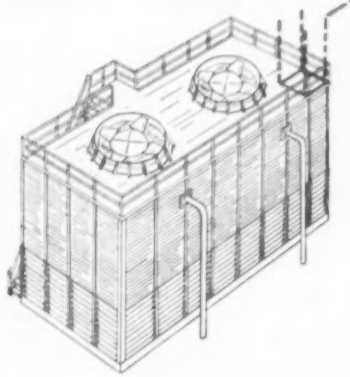
**Redwood Framing,** structurally redesigned to 6'x6' bays, to provide maximum rigidity and conservative loading of all members.

**Simple, Straight-Line Bracing** eliminates all eccentric joints and relieves structural members of horizontal shearing and bending stresses.

**Simple Clevis Anchors** are used on the diagonals, not the posts. Require only one foundation bolt per anchor.

**Self-Leveling Interior Posts** cut to fit basin floor — compensate for irregularities in level and eliminate need for pads or grouting.





THESE are just a few of the many advantages designed into the new Foster Wheeler Cooling Towers. Built of decay-resistant California redwood throughout, this induced-draft counter-flow tower represents an important advance in cooling tower design. Ask your FW representative to give you complete details — or send for additional information. *Foster Wheeler Corporation, 165 Broadway, N. Y. 6, N. Y.*

Detail drawing of a single corner bay of the new Foster Wheeler Induced Draft Cooling Tower. Lower fill racks have been omitted to show structural details to better advantage.

# FOSTER WHEELER

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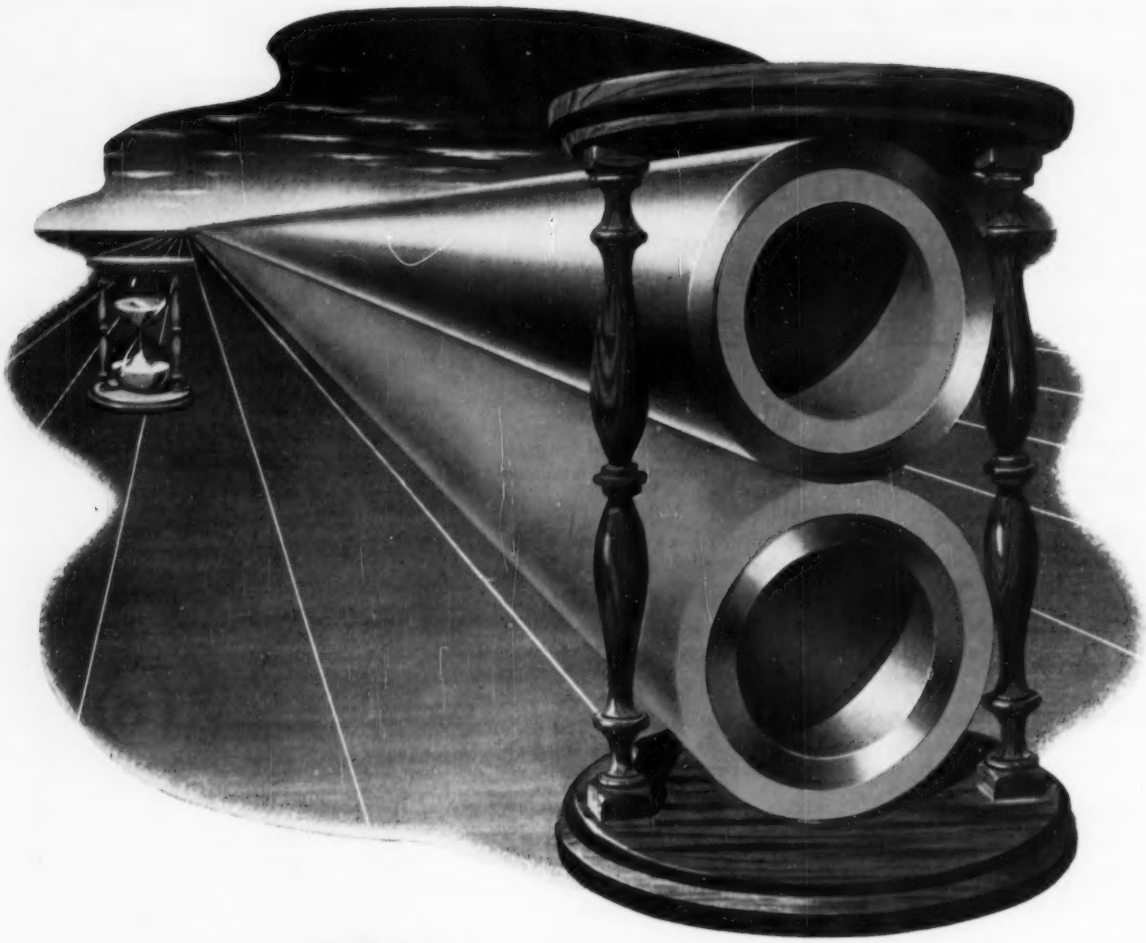
For more data on advertised products, use Readers' Service Cards, last page



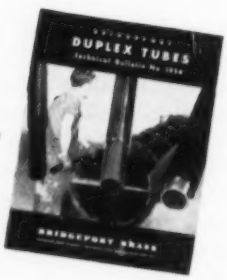
# It's LAST cost that counts!

## . . . and Bridgeport Duplex Tubes last longer

In the long run you save money with Bridgeport Duplex Condenser Tubes! Resisting different types of corrosion, inside and out, they eliminate the need for frequent retubing and shutdowns . . . often improve heat-transfer characteristics . . . reduce maintenance costs substantially when the proper combination of metals is used.

Bridgeport Duplex tubes are available in many combinations to match your service requirements. For example: copper-steel, cupro nickel-lead, red brass-aluminum.

*Call your local Bridgeport Sales Office for complete information and the help of Bridgeport Technical Service. Ask for your copy of Bridgeport's Duplex Tube Technical Bulletin.*




BRASS Bridgeport CO

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Offices in Principal Cities • Conveniently Located Warehouses
Bridgeport Brass Company, Bridgeport 2, Connecticut
In Canada: Noranda Copper and Brass Limited, Montreal

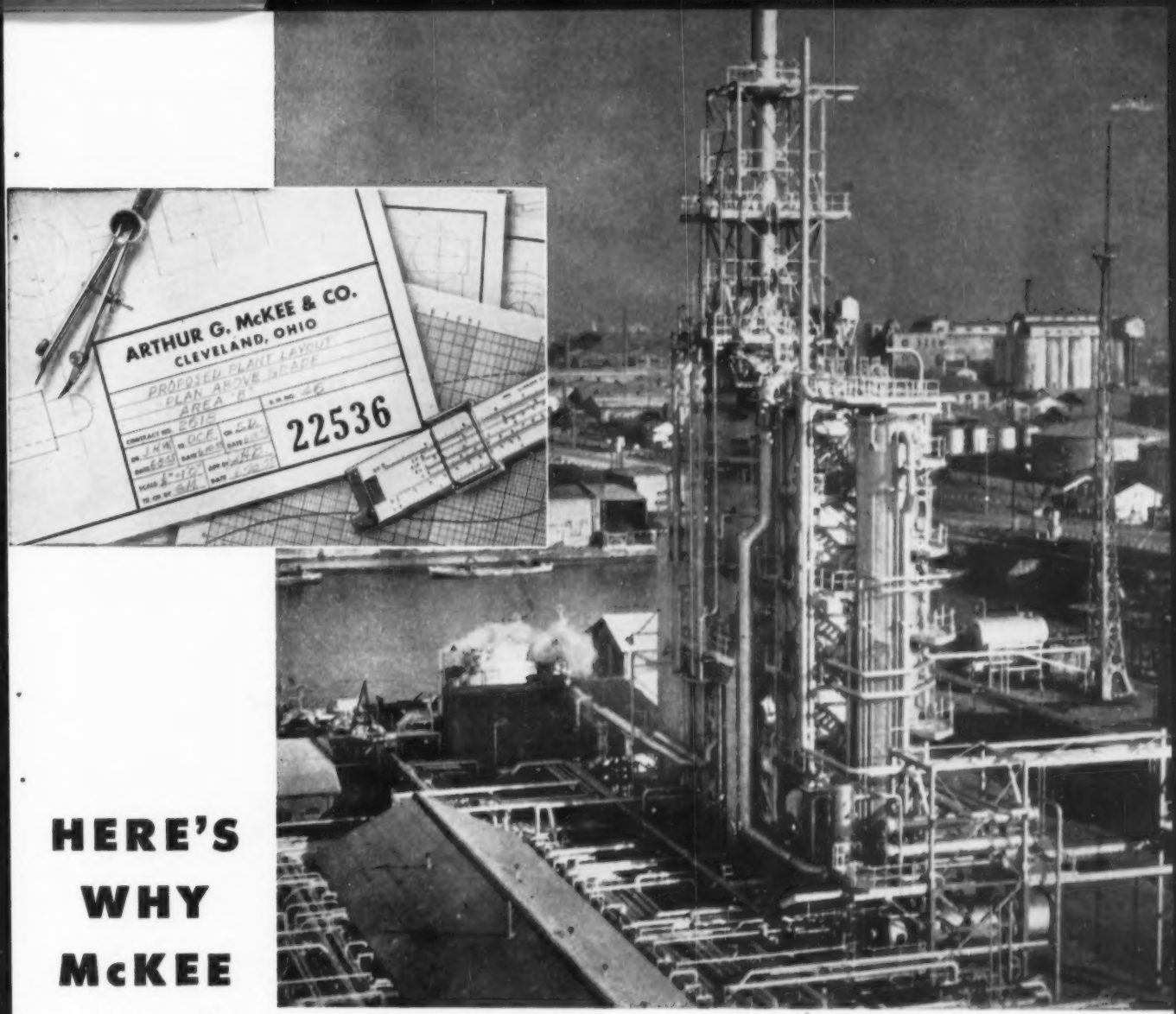
## REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| British American Oil | Moose Jaw, Sask. | Cat. Reforming | | | Planning | | | | |
| British American Oil | Edmonton, Alb. | Cat. Reforming | | | Planning | | | | |
| British-American Oil Co. | Montreal | Cat. Reformer | 13,000 bbls. | $3,000,000 | Completing | | Atlantic | Lummus | Lummus |
| British Dominion Oil Co. | Southern Alberta, Canada | Ammonium Nitrate | | $1,800,000 | Planning (Unconfirmed) | | | | |
| *Cabot Carbon | Sonnia, Ont. | Inc. Carbon Black Cap. | †55,000,000 lb./yr. | | Under Constr. | Early, 1956 | | | |
| Can-Amera Oil-Sands Development, Ltd. | Edmonton, Alta. | Processing Plt. | | | Unconfirmed | | | | |
| Canadian Gulf Oil | Stettler, Alta. | Nat. Gaso. Plt. | 12 Mmcf | $2,000,000 | Under Constr. | March, 1956 | | Mannix Gill | Mannix Gill |
| Canadian Hydrocarbons, Ltd. | Winnipeg, Manitoba | Ammonia Plt. | | | Planning (Unconfirmed) | | | | |
| Canadian Industries (1954) | Millhaven, Ont. | Anhydrous Ammonia Plt. | 200 ton | $9,000,000 | Under Constr. | Mid, 1956 | Texaco | Girdler (Canada) | Girdler (Canada) |
| Canadian Oil Refineries, Ltd. | Sarnia, Ont. | Exp. Crude Unit, Cat Cracker, Platformer | 10,000 bbls. | $2,200,000 | Under Constr. | Oct., 1956 | | Staff | |
| *Canadian Pet. | Montreal | Increase Cap. | | | | | | | |
| Canada Southern Oils | Saskatchewan | Refinery | 10-20,000 bbls. | $7,000,000-$10,000,000 | Planning | | | | |
| *Du Pont | Maitland, Ont. | Orlon Plt. | | | Planning | | | | |
| Ethyl Corporation of Canada, Ltd. | Sarnia, Ont. | Anti-Knock Compound Plt. | | $14,000,000 | Under Constr. | Early, 1956 | | | |
| *Goodrich, Canada | Niagara Falls | Polyvinyl Geon | | $3,500,000 | Planning | Early 1957 | | | |
| *Imperial Oil | Imperoyal, N.S. | Anti-Pollution Equip. | | $500,000 | Completing | | | McKee | McKee |
| *Imperial Oil | Redwater, Ala. | LPG Plt. | 10 Mmcf | $3,000,000 | Planning | Late 1956 | | | |
| Hooker Chemicals, Ltd. | N. Vancouver, B. C. | Chemicals | | | Projected | | | | Brown & Root |
| Imperial Oil | Sarnia | Expan. of Wax Facl. | 35,000,000 lbs./yr. | $4,500,000 | Under Constr. | Late, 1956 | | Fluor, Imperial | Fluor |
| Imperial Oil, Ltd. | Imperoyal, Canada (near Halifax) | Cat. Reformer | 13,500 bbls. | | Under Constr. | Oct., 1956 | | Fluor; Imperial | Fluor |
| | | Rebuild Existing Plt. including Fluid Cat. Cracker | 41,625 bbls. | $22,300,000 | Under Constr. | April, 1956 | | Foster Wheeler, Ltd. | Foster Wheeler Ltd. |
| Inland Chemicals Canada, Ltd. | Fort Saskatchewan, Alta. | Sulfuric Acid Plt. | 100 tons | $1,000,000 | | | | | |
| Kendall Refg. of Canada | Toronto, Canada | Cracker | 27,000 bbls. | | | | | | Lummus of Canada |
| | | Lub. Oil Compounding, packaging & Distrib. Plt. | | | Considering | Summer, 1956 Indefinite | | | |
| Midland Pet. & Pacific Pet. | Stettler, Alta. | Crude Refinery | 4,000 bbls. | $2,000,000 | Under Constr. | | | | |
| North Star Oil | Grand Prairie, Alta. | Re-Locate Refinery | 2500 bbls. | $3,000,000 | Engineering | June, 1956 | Kellogg | Kellogg | Kellogg |
| Northwest-Nitro Chemical | Medicine Hat, Alta | Phosphoric-Acid Plt. | | | | | | | Fluor |
| Northwest Nitro-Chemicals, Ltd. | Medicine Hat, Alberta | Nitrogen Plt. | | $23,000,000 | Under Constr. | End, 1956 | | Commercial Solvents | Ford, Bacon & Davis, Kellogg |
| Polymer Corp., Ltd. | Sarnia, Ont. | Ethylene Plt. Expan. | | $2,000,000 | Under Constr. | 1956 | | Staff | Staff |
| Polymer Corp., Ltd. | Sarnia, Ont. | Additional Turbo-generator—Steam and Power Plt. | | $500,000 | Equipment | 1956 | | | Canadian General Electric |
| Quebec Ammonia | Varennes, near Montreal | Synthetic Ammonia | 120 tons | | Planning | | | | |
| | | Refinery: Crude Unit, Thermal Cracker | 2,000 bbls. | $2,000,000 | Complete | | | Koch | Bohna-Lane |
| Shell Oil (Canada) | Montreal, East | Topping Expan. | 11,000 bbls. | | Planned | Mid, 1956 | | | |
| | | Platformer | 6,000 bbls. | | Planned | Mid, 1956 | | | |
| | | Hydrodesulfurizer | 7,500 bbls. | | Planned | Mid, 1956 | | | |
| | | Increase Cat. Cracking | 3,000 bbls. | | Completing | | | Shell | Shell |
| | | Vacuum Flashing | 12,700 bbls. | | Completing | | | McKee | McKee |
| | | Offsite Facl. | | | Planned | Mid, 1956 | | Fluor | Fluor |
| Shell Oil (Canada) | Shellburn B.C. | Platformer | 2,750 bbls. | | Under Constr. | | U.O.P. | | Procon |
| Sherritt-Gordon Mines, Ltd. | Fort Saskatchewan, Alta. | Platformer | 3,300 bbls. | $1,500,000 | Completing | | | | |
| | | Anhydrous Ammonia | 75 tons | $24,000,000 | Planned | | | | |
| Standard Oil (B.C.) | Stanovan, B.C. | Platformer | 2,750 bbls. | $2,500,000 | Completing | | Standard (B.C.) | Procon Can. | Procon, Can. |
| *Surpass Petro-Chemicals | Scarborough, Ont. | Sulphonates | | | Under Constr. | 1956 | | | |
| Wainwright Producers & Refiners | Edmonton, | Cap. Inc. | †2,300 bbls. | | Under Constr. | | | Treco | Treco |
| X-L Refineries | Dawson Creek, B.C. | Refinery | 2000 bbls. | $2,000,000 | Complete | | Koch, Houdry | Koch | Bohna; Lane |
| **LATIN AMERICA** | | | | | | | | | |
| **Argentina** | | | | | | | | | |
| Esso Refinadora Petroleo, S.A. | Argentina | Lubricating Oil Plt. | 375,000 bbls. a year | | Planning | | | | |
| Fabrica Argentina | San Nicholae | Phenol Plt. | | $375,000 | Planning | Fall, 1956 | | | |
| **Brazil** | | | | | | | | | |
| Cia de Petroleo de Amazonia | Manaus | Refinery; Cat. Crker. & Aux. Units | 5,000 bbls. | $4,500,000 | Under Constr. | Jan., 1956 | U.O.P. | Sweco | Montreal |
| Cia Braziliera de Estireno | Cubatao | Styrene Monomer Plt. | | | Engineering | | Koppers, Firestone | Koppers | Koppers |
| | | Asphalt Plt. | 3,500 bbls. | $1,300,000 | Complete | | | SWECO | Montreal |
| | | Anhydrous Ammonia | 100 tons | $8,000,000 | Under Constr. | Early, 1956 | Texaco Dev., Ammonia Cassle | Foster Wheeler | Foster Wheeler Staff |
| | | Nitric Acid | 345 tons | | | | | | |
| | | Ammonian Nitrate Fertilizer | 33 tons<br>340 tons | $11,000,000 | Under Constr. | Early, 1956 | | Friedrich Uhde Uhde | Uhde, Staff |
| *Petrobras | Cubatao | Ethylene Recov. | 30,000,000 lb./yr. | $1,800,000 | Engineering | Fall, 1956 | | Kellogg | Kellogg |
| Petrobras | North Brazil | Refinery | 25,000 bbls. | | Studying | | | Hydrocarbon, Hydro. M. | Staff |
| Petrobras | South Brazil | Refinery | 70,000 bbls. | | Studying | | | | |
| **Colombia** | | | | | | | | | |
| Colombian Petroleum Company | Barco Concession | Gas Treating Plt. | 2,000 bbls. | $5,000,000 | Under Constr. | | | | |

## REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| International Petroleum (Columbia), Ltd. | Cartagena | Refinery | 25,000 bbls. | $35,000,000 | Planned | Late 1957 | ..... | ..... | ..... |
| **Cuba** | | | | | | | | | |
| Esso Standard | Havana | Ref. Exp. | †30,000 bbls. | $3,000,000 | Planning | ..... | ..... | ..... | ..... |
| Refinadora Cabaiguan | Cabaiguan, Cuba | Ref. Expan. | ..... | ..... | Planning | ..... | ..... | ..... | ..... |
| Shell de Cuba | Havana | Refinery | 25,000 bbls. | ..... | Planning | Nov., 1956 | ..... | ..... | Bechtel |
| The Texas Co. | Santiago | Refinery | 20,000 bbls. | $14,000,000 | Under Constr. | Early, 1957 | ..... | Procon | Procon |
| **Mexico** | | | | | | | | | |
| Cia Commercial Vacuum | Mexico, D.F. | Lube Oil Blending, Compounding | 570 bbls. | $700,000 | Planning | 2nd Qtr., 1956 | ..... | ..... | ..... |
| Petroleos Mexicanos | Ciudad Madero Tamaulipas | Enlarge, Modern. Feed prep. Cat. Crker. Fluid-coker, Offsite | 100,000 bbls. | $30,000,000 | Planned | Early 1957 | ..... | ..... | ..... |
| Petroleos Mexicanos | Mata Redonda | Refinery Expan. | ..... | ..... | Planning | ..... | ..... | ..... | ..... |
| Petroleos Mexicanos | Pacific Coast | Refinery | 30,000 bbls. | ..... | Planned | ..... | ..... | ..... | ..... |
| Petroleos Mexicanos | Tampico | Refinery Expan. | ..... | ..... | Planning | ..... | ..... | ..... | ..... |
| **Netherlands Antilles** | | | | | | | | | |
| *Largo O&T | Aruba | Expand Distillates Upgrading Fac. | †20,000 bbls. | $3,200,000 | Planning | ..... | ..... | Badger | Badger |
| N. V. Curacaosche Petro. Ind. Mij. | Curacao | Feed Prep. | 20,000 bbls. | Part of $56,000,000 Project | ..... | Mid 1957 | ..... | S & W. Badger Div. | ..... |
| | | Cat. Crker. | 35,000 bbls. | ..... | Planned | End, 1957 | ..... | ..... | ..... |
| **Peru** | | | | | | | | | |
| Fertiza Limitada | Peru | Fertilizer Plt. | ..... | ..... | Planning | 1956 | ..... | Montecatini | ..... |
| Helios, S.A. | San Andres | Fertilizer Plt. | 130,000 tons | ..... | Planning | ..... | ..... | ..... | ..... |
| Helios, S.A. | San Andres | Lube Oil; Asphalt Refinery | 60,000 tons lube oil; 10,000 tons Asphalt/yr. | $8,000,000 | Under Constr. | Early 1956 | ..... | Hydrocarbon | ..... |
| **Puerto Rico** | | | | | | | | | |
| Americo Rodriquez | San Juan | LPG Plt. | 12,000 bbls. | ..... | Complete | ..... | ..... | Fluor | Fluor |
| Commonwealth Oil Refining Co. | Guayanilla Bay | Refinery: | 25,000 bbls. | $25,000,000 | Completing | ..... | ..... | Lummus | Lummus |
| | | Houdriflow Cat. Crker. | 26,800 bbls. | ..... | ..... | ..... | ..... | ..... | ..... |
| | | Houdriformer | 3,730 bbls. | ..... | ..... | ..... | ..... | ..... | ..... |
| Gonsales Chemical | Guanica | Ammonia | 125 tons | $12,250,000 | Under Constr. | Late 1956 | Texaco | Lummus | Lummus |
| **Venezuela** | | | | | | | | | |
| Cia Shell de Venezuela | Cardon | Cat. Crker. | 35,000 bbls. | Part of $56,000,000 Project | Planned | End, 1957 | ..... | ..... | ..... |
| Cia Shell de Venezuela | Cardon | Polymerization; Treater, Feed Preparation | ..... | ..... | Planning | ..... | ..... | H.W.P. | ..... |
| Cia Shell de Venezuela | Cardon | Feed Prep. | 66,000 bbls. | ..... | ..... | 1956 | ..... | S & W Badger Div. | ..... |
| Creole Pet. Corp. | Amuay Bay | Pipe Still | 100,000 bbls. | $70,800,000 | Engineering | August 1956 | ..... | Foster Wheeler | Foster Wheeler |
| Richmond Exploration | Maracaibo | Asphalt Plt. | 10,000 bbls. | $4,000,000 | Under Constr. | ..... | ..... | ..... | ..... |
| Venezuelan Government | Puerto La Cruz | Petrochemical Plt. | ..... | ..... | Planning (Unconfirmed) | 1956 | ..... | Montecatini | ..... |
| Venezuela Gulf | Puerto La Cruz | Visbreaker | 14,000 bbls. | ..... | Under Constr. | 2nd Qtr., 1956 | ..... | Gulf | Gulf |
| **EUROPE AND AFRICA** | | | | | | | | | |
| **Belgium** | | | | | | | | | |
| Esso | Antwerp | Exp. Ref. | ..... | ..... | Planning | ..... | ..... | ..... | ..... |
| Petrochim | Antwerp | Ethylene Oxide, Ethylene Glycol | ..... | $8,000,000 | Engineering | ..... | SD | SD | ..... |
| **Denmark** | | | | | | | | | |
| A. P. Moeller | Copenhagen | Refinery | ..... | $11,500,000 | Planning | ..... | ..... | ..... | ..... |
| **Egypt** | | | | | | | | | |
| Anglo-Egyptian | Suez | Ref. Expan. & Mod. | ..... | ..... | Planning | ..... | ..... | ..... | ..... |
| Egyptian Government | Cairo | Refinery | 43,000 bbls. | ..... | Under Constr. | ..... | ..... | Lummus | Lummus |
| **England** | | | | | | | | | |
| Berry Wiggins & Co., Ltd | Weaste Ref., Manchester. | Extension to Refinery | 500 bbls. | ..... | Under Constr. | ..... | ..... | H.W.P. | H.W.P. |
| British Petroleum, South Eastern Oil-Gas Board | Kent | Oil Gasification | 15 Mmcf | ..... | Planning | ..... | ..... | ..... | ..... |
| British Petroleum | Kent | Hydrofiner | 8000 bbls. | ..... | Planning | 1956 | ..... | KIC | KIC |
| *British Petroleum | Kent | Alkylation Plt. | 2,600 bbls. | $18,000,000 | Planning | 1958 | ..... | ..... | ..... |
| Esso Petroleum Co. | Fawley | Refinery Expan. Including Hydroforming Unit | †35,000 bbls. | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| Hedon Chemicals | Hedon, Yorks. | Vinyl Acetate | ..... | ..... | Under Constr. | ..... | ..... | ..... | ..... |
| *Imperial Chemicals | Billingsham | Ammonia Plt. | 200 tons | ..... | Planning | ..... | Texaco | Imperial | Imperial |
| Imperial Chemical Industries | Billingsham | Alcohols | †40,000 tons/yr. | ..... | Engineering | End, 1956 | ..... | Staff | ..... |
| Imperial Chemical Industries | Wilton | Chemical Plt. | 30 tons | ..... | ..... | 1956 | ..... | S & W Badger Div. | E. B. Badger & Sons, Ltd. |
| Imperial Chemical Industries | Wilton | Terylene Plt. | 22 mln. lbs./yr. | $50,000,000 | Complete | ..... | ..... | ..... | ..... |
| Imperial Chemical Industries | Wilton | Butadiene Separation Plt. | 6/7000 ton/yr. | ..... | Design | ..... | ..... | H.W.P. | ..... |
| Imperial Chemical Industries | Wilton | Extension of Cracker | †250,000 tons/yr. | ..... | Under Constr. | 3rd Qtr., 1956 | ..... | Staff and Kellogg | KIC |
| Monsanto Chemicals | Britain | Add Polystyrene | ..... | ..... | Under Constr. | ..... | ..... | Staff | Staff |
| Monsanto Chemicals | Britain | Styrene-Butadiene Copolymer Plt. | 4,000 tons/yr. | $14,000,000 | Planned | ..... | ..... | ..... | ..... |
| *Shell Chemical | Essex | Alkyl Benzene | 20,000 tons/yr. | $3,500,000 | Under Constr. | Early 1956 | ..... | ..... | ..... |
| Shell Refining & Marketing Co. | Shell Haven | Cat. Reformer | 6,700 bbls. | ..... | Completing | ..... | ..... | ..... | ..... |
| Vacuum Oil | Coryton | Sovaformer | ..... | ..... | Engineering | July, 1956 | ..... | Bechtel | Bechtel |
| **Finland** | | | | | | | | | |
| Neste Oy Corp. | Turku, Finland | Refinery | 14,000 bbls. | $17,500,000 | Planning | ..... | Atlantic, Soc. Mob., Calif. Res. | ..... | ..... |
| **France** | | | | | | | | | |
| Antar Petroles de l'Atlantic | Donges | Cat. Reformer | 10,800 bbls. | ..... | Engineering | ..... | Houdry, U.O.P. | Hydrocarbon, Hydro M. | Staff |
| Comp. de Raffinage Shell Berre | Petit Couronne | Cat. Crker. | 12,000 bbls. | ..... | Under Constr. | Mid 1956 | ..... | ..... | ..... |
| | | Feed Prep. | 28,000 bbls. | ..... | ..... | 1956 | ..... | S & W Badger | ..... |
| Comp. Francaise de Raffinage | Gonfreville | Refinery Expan. | ..... | ..... | Under Constr. | Mid, 1956 | ..... | Kellogg | KIC |

■ Construction Boxscore Continued on Page 224

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## REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| *Esso Standard | Port Jerome | Cat. Cracker | 10,000 bbls. | $11,000,000 | Planning | Early 1957 | | | |
| Pechiney | St. Auban | Perchlorethylene Plt. | | | Planning | | SDC | SDC | |
| Societe du Caoutchouc Butyl | Le Havre | Synthetic Rubber Plt. | 20,000 tons/yr. | | Planning | Mid 1958 | | | |
| Societe des Raffineries de Petrole de la Gironde | Ambes | Cat. Crker. | 4,600 bbls. | | Engineering | 1957 | U.O.P. | U.O.P. | Lummus |
| | | Vacuum Unit | 6,300 bbls. | | Engineering | 1956 | | Lummus | Lummus |
| | Ambes | Poly Plt. | 540 bbls. (Product) | | Engineering | 1956 | C.R.C. | Foster Wheeler | Lummus |
| **West Germany** | | | | | | | | | |
| British Petroleum | Hamburg | Hydrofiner | 5250 bbls. | | Planning | 1956 | | | |
| Chemische Werke Huels, A.G. | West Germany | Synthetic Rubber Plt. | 30,000 t/y | $24,000,000 | Considering | | Esso R&E; Houdry | Cat. Constr. | |
| Deutsche Shell | Hamburg | Exp. Ref. | †52,000 bl'a. | | Planning | | | | |
| Esso | Cologne | Refinery | | | Planning | | | | |
| *Establissements Kuhlmann | | Ammonia Plt. | 60 tons | | Under Constr. | Spring, 1956 | Texaco | Kuhlmann | Kuhlmann |
| Gewerkschaft Erdoel Raffinerien Emsland | Lingen | Houdriformer | 3,500 bbls. | | Completing | | Houdry | Lummus | Lummus |
| Kali Chemie Co. | Neinberg | Read Catalyst Plt. | | | Licensed | | Soc.-Vac. | | |
| Kohle-Oil Chemie | Gelsenkirchen | Polyethylene | 24,000 ton/yr. | | Planning | | | | |
| **Greece** | | | | | | | | | |
| Greek Government | Piraeus | Refinery | 30,000 bbls. | $15,000,000 | Under Constr. | Jan., 1957 | Atlantic | Hydrocarbon | Hydro. M, Krupp, Stahlunion, Stahlbau |
| **Ireland** | | | | | | | | | |
| Erie Government | Ireland | Refinery | | | Planning | | | | |
| Esso Petr. (Ireland) | | | | | | | | | |
| Caltex (Ireland) | | | | | | | | | |
| Irish Shell | | | | | | | | | |
| **Italy** | | | | | | | | | |
| Ente Nazionale Idrocarburi | Ravenna | Butadiene Plt. | 30,000 tons a yr. Rubber | 75,000,000 | Planning | | | Union Carbide Carbon; | Brown-Root |
| | | Copolymer Plt. | 350,000 tons a year, Nitrogen Fertilizers | | Planning | | | Phillips Petroleum | Brown-Root |
| Azienda Generale Italiana Petroli | Venice | Platformer | 1,750 bbls. | | Under Constr. | | | | |
| Azienda Generale Italiana Petroli | Cagliari | Refinery | 500,000 tons | | Planning | | | | |
| Golfo Industria Petrolifera S.P.A. | Gaeta, Italy | New Refinery | 15,000 bbls. | | | | | Tecnider | |
| Industria Raffinazione Olii Minerali | Venice | Platformer | 2,000 bbls. | | Completing | | U.O.P. | Procon | C.T.I.P. |
| Montecatini | Barranca Bermeja | Anhydrous Ammonia Plt. | 50 tons | | Planning (Unconfirmed) | | | | |
| Purfina Italiana, | Genoa | Platformer | 1,000 bbls. | $550,000 | Designing | Spring, 1956 | U.O.P. | Staff | Staff |
| Purifina Italiana | Milan | Distillation Unit | †5,000 bbls. | | Planning | | | | |
| Shell Italiana | Palermo | Refinery | 20,000 bbls. | | Planning | | U.O.P. | U.O.P., E. B. Badger, Ltd. | S&W Badger Div. |
| Societa Per Azioni Raffineria Olii Minerali (SAROM) | San Martino di Trecate (Novara) | Cat. Crker. | 2,880 bbls. | | Nearing Completion | | | S&W Badger | S&W Badger Div. |
| | | Vacuum Unit | 5,150 bbls. | | Under Constr. | | | | |
| | | Poly. Plt. | 315 bbls. | | Under Constr. | | C.R.C. | Foster Wheeler | S&W Badger Div. |
| SAROM | Ravenna | Iso-Plus Houdriformer | 4000 bbls. | | Under Constr. | June, 1956 | Houdry | Houdry; Lummus | Breda |
| **Netherlands** | | | | | | | | | |
| Caltex Petroleum | Pernis | Platformer | 7,000 bbls. | | Engineering | 1957 | U.O.P. | Lummus, Ltd. | Lummus-Werkspoor |
| | | Desulfurization | 4,000 bbls. | | Engineering | 1957 | U.O.P., Union | Lummus, Ltd. | Lummus-Werkspoor |
| Mekog | Velsen-Ymuiden | Nitrigen Fertilizer | | $9,000,000 | Planning | | | | |
| Nederlandsche Dow Maatschappij N.V. | Rotterdam | Petrochemical Plt. | | | Planned | | | | |
| *N. V. de Bataafsche Pet. Maatschappig | Pernis | Syn. Glycerine | | $7,000,000 | Planning | | | | |
| N. V. de Bataafsche Pet. Maatschappij | Pernis | Vacuum Still | 66,000 bbls. | | Completing | | | S&W Badger Div., E. B. Badger, Ltd. | |
| | | Cat. Crker. | 33,000 bbls. | | Under Constr. | Mid 1956 | | | |
| **Morocco** | | | | | | | | | |
| Societe Cherifienne des Petroles | Petitjean | Thermofor Cat. Crack. | 160,000 tons/yr. | | Planning | | | | |
| **Portugal** | | | | | | | | | |
| Petrofina | Luanda | Refinery | 30,000 bbls. | | Planning | | | | |
| **Scotland** | | | | | | | | S&W Badger Div. | E. B. Badger, Ltd. |
| British Pet. Chemical | Grangemouth | Additional Cracking | | | Planning | | | S&W Badger Div. | E. B. Badger, Ltd. |
| | | Gas-Separating | | | Planning | | Shell Chem. | S&W Badger Div. | E. B. Badger, Ltd. |
| | | Ethanol, Ethylene, Tetrapropylene | | $13,000,000 | Planning | 1956 | UOP | KIC | KIC |
| | | Butadiene | | | Planning | | | S. W. Badger Div.; E. B. Badger & Sons | Costain-John Brown |
| Grange Chemicals | Grangemouth | Dodecybenzene Plt. | 35 tons | | Completing | | | | |
| **Spain** | | | | | | | | | |
| Instituto Nacional de Industria | Cartagena | Refinery Expan. | †70,000 bbls. | | Planning | | | | |
| Refineria de Petroleos de Escombreras S.A. | | Crude Unit | 23,000 bbls. | | Engineering | 1956 | | Foter Wheeler | |
| | | Platformer | 8,000 bbls. | | Engineering | 1956 | | U.O.P., Foster Wheeler | |
| **Sweden** | | | | | | | | | |
| Johnson Line | Gothenburg | Refinery | 2,500 bbls. | | Planned | | | Staff | Staff |
| **Trieste** | | | | | | | | | |
| S.P.A. Tecnico Industriale Aquila | Trieste | Cat. Cracking | 3,300 bbls. | | Under Constr. | | Soc.-Vac. | Staff | Staff |
| | | Cat. Poly. | 1,400 bbls. | | Under Constr. | | U.O.P. | Staff | Staff |
| **Turkey** | | | | | | | | | |
| *Badische Anilin and Soda Fabrik | Kutefia | Ammonium Sulfate | 60,000 tons/yr. | $20,000,000 | Planning | 1958 | | | |
| | | Sulfuric, Nitric Acid | 50,000 ton/yr. | | | | | | |
| Turkish Government | Istanbul | Nat. Gaso. Plt. | | | Planning | | | Parsons | Parsons |
| Turkiye Petrolleri A.O. | Batman | Refinery | 6,950 bbls. | $10,000,000 | Under Constr. | | | | |
| **Union of South Africa** | | | | | | | | | |
| Caltex (Africa) | Durban | Blending Lube Plt. | | $600,000 | Under Constr. | 1st Half 1956 | | | |

■ Construction Boxscore Continued on Page 226

# THE CASE OF THE RECALCITRANT TUBE

**FACTS:** High pressure, high temperature refinery application (hydrogenation of petroleum)
Tubing in question was stainless type 347
Tubing met original specification for job

**CLUES:** Tubing was in service for about 100 hours at a pressure of 10,000 psi and a temperature of 1100 F, before failure.

**EXAMINATION REVEALED:** Temperatures and/or pressures used in actual testing or operation exceeded the original specifications

Failure resulted from progressive wall thinning due to creep

**POSSIBLE SOLUTIONS:** Change operating conditions
Use a thicker wall tube. Change tube material

**B&W SUGGESTION:** When it comes to choosing a tube, consider *every* factor involved, including possibility of exceeding current service conditions. *And* get the benefits of Mr. Tubes' long experience with tubing for every kind of application. He knows his tubes—what they will and what they won't do. Call him in at any time. He's as close as the phone at your elbow.

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For more data on advertised products, use Readers' Service Cards, last page

## REFINERY AND OTHER PLANT CONSTRUCTION—*Continued*

| COMPANY | Plant Site | Project | Daily Capacity | Estimated Cost | Status | Probable Completion | Licensor | Engineering | Contractor |
|---|---|---|---|---|---|---|---|---|---|
| Union Petrol Refinery, Ltd | Johannesburg | Refinery | ..... | $20,000,000 | Projected | ..... | ..... | ..... | ..... |
| **Yugoslavia** | | | | | | | | | |
| Yugoslavia Government | Makarska | Refinery | ..... | ..... | Planning | ..... | ..... | ..... | ..... |
| **NEAR EAST** | | | | | | | | | |
| **Bahrain** | | | | | | | | | |
| Bahrain Petroleum | Bahrain | Vacuum Still | 23,000 bbls. | ..... | Under Constr. | ..... | ..... | Lummus | Foster Wheeler |
| | | Cat. Crker. | 18,000 bbls. | ..... | Engineering | 1957 | ..... | Foster Wheeler | Foster Wheeler |
| | | Poly Plt. | 1,500 bbls. | ..... | Engineering | 1956 | ..... | Foster Wheeler | Foster Wheeler |
| | | Vacuum Still | 23,000 bbls. | ..... | Under Constr. | 1956 | ..... | Lummus | Foster Wheeler |
| **Iraq** | | | | | | | | | |
| Iraq Government | Iraq | Lube Oil Plt. | 25,000 ton/yr. | ..... | Planning | ..... | ..... | Foster-Wheeler | Foster-Wheeler |
| **Jordan** | | | | | | | | | |
| Jordanian Reconstruction Council | Mafrak | Refinery | ..... | $7,500,000 | Planned | ..... | ..... | ..... | ..... |
| **Lebanon** | | | | | | | | | |
| Mediterranean Refinery | Sidon | Refinery Expan. (Increase Crude Unit; Second Platformer) | 19,000 bbls.† | ..... | Complete | ..... | U.O.P. | Bechtel Asso., Procon | Bechtel Asso. |
| **Saudi Arabia** | | | | | | | | | |
| Arabian American | Ras Tanura | Asphalt Plt. | 1,250 bbls. | ..... | Planning | 1956 | ..... | ..... | ..... |
| Arabian American Oil Co. | Ras Tanura | Fluid Cat. Hydroformer | 12,500 bbls. | $9,825,000 | Complete | ..... | S.O.D. | Lummus | Lummus |
| Saudi Arabian Government | Saudi Arabia | Ammonium Sulfate Plt. | 400,000 Metric tons/yr. Plus 500 Tons Dry Ice | ..... | Proposed | ..... | ..... | ..... | ..... |
| **Syria** | | | | | | | | | |
| Syrian Government | Homs | Refinery | 12,000 bbls. | $3,000,000 | Considering | ..... | ..... | ..... | ..... |
| **FAR EAST** | | | | | | | | | |
| **Ceylon** | | | | | | | | | |
| Shell of Ceylon | Hendala | Refinery | ..... | $40,000,000 | Negotiating | ..... | ..... | ..... | ..... |
| **India** | | | | | | | | | |
| *Assam Oil | Assam | Refinery | ..... | ..... | Considering | ..... | ..... | ..... | ..... |
| Caltex Oil Refining (India) Ltd. | Visakhapatnam | Refinery | 13,500 bbls. | ..... | Under Constr. | 1957 | ..... | Lummus Foster Wheeler Ewbank & Tardreas | Lummus |
| *Dow et al | Bombay | Polystyrene Plt. | 2,700 ton/yr. | ..... | Planning | ..... | ..... | ..... | ..... |
| *Indian Gov't | Bhavnagar | Refinery | 30,000 bbls. | $42,000,000 | Considering | ..... | ..... | ..... | ..... |
| Indian Government | India | Synthetic Petroleum Plt. | 6,000 bbls. | ..... | Planning | ..... | ..... | ..... | ..... |
| *Standard Vacuum | Bombay | Cat. Polymerization | 350 bbls. | ..... | Under Constr. | ..... | Calif. Res. | Hydrocarbon | Foster Wheeler |
| **Japan** | | | | | | | | | |
| Idemitsu Kosan Co. | Tokuyama | Refinery | 18,000 bbls. | $16,000,000 | Planning | ..... | ..... | ..... | ..... |
| Mitsubishi Oil Co., Ltd. | Tokyo | Vac. Distl. Unit | 2,000 bbls. | ..... | ..... | ..... | ..... | ..... | ..... |
| Showa Oil Company | Tokuyama | Refining Fac. | 30,000 bbls. | $39,000,000 | Planning | June, 1957 | ..... | ..... | ..... |
| Showa Oil Company | Tokuyama | Petrochemicals | ..... | ..... | Planning | ..... | ..... | ..... | ..... |
| **Korea** | | | | | | | | | |
| Korean Government | Chung-ju | Urea Plt. | 185 tons | $25,000,000 | Under Constr. | ..... | Vulcan, Inventa, Texaco, Hydrocarbon | Hydrocarbon | Hydrocarbon |
| **Sumatra** | | | | | | | | | |
| Standard-Vacuum | Palembang | Cat. Cracker | 10,000 bbls. | | | ..... | ..... | Foster-Wheeler | Foster-Wheeler |
| | | Polymerization | 1100 bbls. | $20,000,000 | Planning | ..... | ..... | Foster-Wheeler | Foster-Wheeler |
| | | Revamp Existing Plt. | ..... | | | ..... | ..... | Foster-Wheeler | Foster-Wheeler |
| **Formosa** | | | | | | | | | |
| Chinese Petroleum Corp. | Kaohsiung | Thermofor Cat. Crker. | 10,000 bbls. | ..... | Under Constr. | 1956 | Soc.-Vac. | Fluor | Fluor |
| | | Cat. Reformer | 3,100 bbls. | ..... | Under Constr. | ..... | Atlantic | Blaw-Knox | Blaw-Knox |
| Taiwan Fertilizer, Ltd. | Nankong | Ammonia Plt. to Produce Urea | 260 tons | $18,000,000 | Under Constr. | Spring, 1957 | Vulcan, Inventa | Hydrocarbon | Staff |
| **AUSTRALASIA** | | | | | | | | | |
| **Australia** | | | | | | | | | |
| Socony-Vacuum | Altona | Alkylation Unit | 1,700 bbls. | ..... | Planned | Aug., 1956 | ..... | Kellogg | KIC |
| Standard-Vacuum | Melbourne | Alkylation | ..... | ..... | Complete | ..... | ..... | Braun, Soc.-Vac. | Braun |
| **Phillipine Islands** | | | | | | | | | |
| Edgington Oil Ref. | Manila | Asphalt Plt. | ..... | $3,000,000 | Planning | ..... | ..... | ..... | ..... |

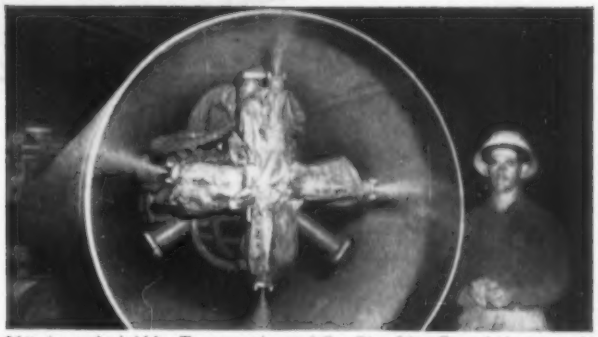
* First appearance in tabulation  † Added capacity

NOTE:

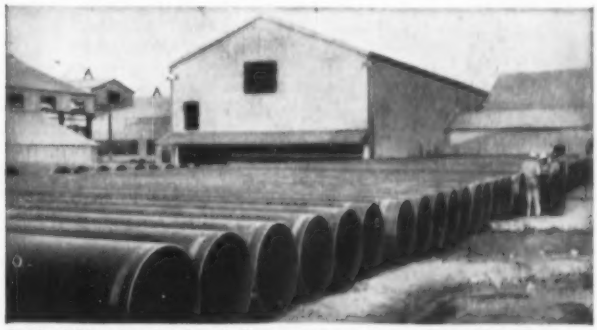
Armistead—George Armistead & Co.
Atlantic—Atlantic Ref. Co.
Austin—Austin Co.
Badger Mfg.—Badger Manufacturing Co.
E. B. Badger Ltd.—E. B. Badger & Sons Ltd.
E. B. Badger Pty.—E. B. Badger & Sons Pty., Ltd.
Barnes—W. M. Barnes Co.
Bechtel—Bechtel Corp.
Beck—Henry C. Beck
Blaw-Knox—Blaw-Knox Co.
Braun—C. F. Braun Co.
Breda—Breda Electromeccanica Locomotive
Brown & Root—Brown & Root Construction Co.
Buckner—F. J. Buckner Corp.
Calif. Res.—California Research Corp.
Can. Kellogg—Canadian Kellogg Co.
Cat. Constr.—Catalytic Construction Co.
Chemico—Chemical Construction Co.
Ch. Pro.—Chemical Process, Inc.
C. B. & I.—Chicago Bridge & Iron Co.
Chiyoda—Chiyoda Chemical Engineering & Construction Co., Ltd.
C. & I.—Chemical & Industrial Corp.
Consd. Eng.—Consolidated Engineering Company
Craig—A. F. Craig & Co.
C.T.I.P.—Compagnia Tecnica Industria Petroli
D & Z—Day & Zimmerman
Delta—Delta Engineering Corp.
Dresser—Dresser Engineering Corp.
Ebasco—Ebasco Services, Inc.
E&A—Ehrhart & Arthur, Inc.
Esso R&E—Esso Research and Engineering Co.
Edeleanu—Edeleanu Gesellschaft M.B.H.
Etanadger S.A.—Etablissement Badger, S.A.
F&C—Farnsworth & Chambers Co., Inc.
Ferguson—H. K. Ferguson Co.
Fish—The Fish Engineering Corp.
Fluor—Fluor Corp.
Foster Wheeler—Foster Wheeler Corp.
Gas Plant Constr.—Gasoline Plant Const. Corp.
Girdler—The Girdler Co.
Girdler (Canada)—Girdler Corp. of Canada, Ltd.
Graff—Graff Engineering & Equipment
Gravr—Gravr Construction Co.
Grebe & Doremus—Grebe & Doremus Process Co.
Gutte-Hutte—Gutehoffnungshuette
Hercules—Hercules Powder Co.
Hudson—Hudson Engineering Corp.
H.W.P.—Head Wrightson Process, Ltd.
Hydrocarbon—Hydrocarbon Research, Inc.
Hydro M—Hydrocarbon Mineralol G.m.b.H.
Hydro E—Hydrocarbon Engineering S.A.R.L.
Kaiser—Kaiser Engineers
Kellogg—The M. W. Kellogg Co.
Kellogg P A—Kellogg Pan American
KIC—Kellogg International Corp.
Koch—Koch Engineering Company
Koppers—Koppers Co., Inc.
Lummus—The Lummus Co.
Macco—Macco Corp.
Mannix Gill—Mannix Gill, Ltd.
McKee—Arthur G. McKee Co.
M-C & S—Merritt-Chapman & Scott Corp.
Olsen—O. L. Olsen
P. A. HydroRes—Pan-American Hydrocarbon Research Co.
Parker—Parker, Steffens & Pearce
Parsons—The Ralph M. Parsons Co.
Phillips—Phillips Petroleum Co.
Pritchard—J. H. Pritchard Co.
Procon—Procon, Inc.
Quaker—Quaker Valley Constructors
Russell—Russell Engineering Corp.
Rust—Rust Engr. Co.
SD—Scientific Design
S & S—Singmaster & Breyer Separator-Nobel Co.
Soc. Mob.—Socony-Mobil Oil Co.
Southwestern—Southwestern Constr. Co.
Sohio—Standard Oil Co. of Ohio
Stearns-Roger—Stearns-Roger Mfg. Co.
Sunland—Sunland Refining Co.
S & W Badger Div.—Stone & Webster Engineering Corp., Badger Process Div.
S & W Canada Ltd.—Stone & Webster Canada Ltd.
Sweco—Southwestern Engineering Co.
Tears—Tears Engineers
Tecnider—Tecnica Idrocarburie Derivati
Tellepsen—Tellepsen Construction Co.
Texaco Dev.—Texaco Development Corp.
Texaco—The Texas Co.
Texas Natural—Texas Natural Gasoline Corp.
Treco—Refinery Engineering Co.
U.O.P.—Universal Oil Products Co.
Vulcan—Vulcan Engineering Div.
J. G. White—J. G. White Eng. Corp

# EPON® RESIN does it!

## New Internal Coating *protects pipelines against corrosion by crude oil, salt water, gas*



**36" pipe** to be laid by Transcontinental Gas Pipe Line Corp. being coated with *Copon*, containing Epon resin. *Copon* is manufactured by Coast Paint and Lacquer Co., Houston.



**Stock of 36" pipe,** lined with Epon resin coating, to be used by Transco.

## HERE'S HOW...

INTERNAL CORROSION of gas pipe lines has long been a costly maintenance problem. The solution is an Epon resin coating that stands up to corrosives, that does not flake or peel off, that can be readily applied.

Such an Epon resin-based enamel is now going to work in nearly 300 miles of line for Transcontinental Gas Pipe Line Corp.

It's a *one-coat*, amine-catalyzed system which, cured at atmospheric temperatures, gives the performance of many baked finishes never before obtained with any other cold-cure coating. The Epon resin liner has complete adhesion to metals and extreme resistance to corrosion that keeps gas free of rust and pipe scale.

If you need a paint that lasts longer, that has excellent adhesion, resistance to abrasion and impact, ability to withstand a wide range of temperatures, humidity and corrosive atmospheres . . . ask for *Epon resin coatings*. Call on our sales offices for names of suppliers. Write for the full Epon coatings story in the brochure, "Planning to Paint a Pyramid?"

*Epon resins are the epoxy polymers made exclusively by Shell Chemical Corporation.*

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**Chemical Partner of Industry and Agriculture**

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**Chemical Division, Shell Oil Company of Canada, Limited**
**Toronto • Montreal • Vancouver**



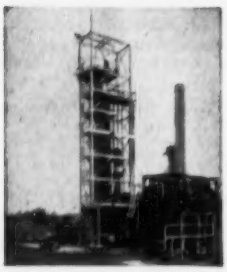
For more data on advertised products, use Readers' Service Cards, last page.

# NEW UNITS FOR PETROFINA

## *Completed by* LUMMUS

✓ AHEAD OF SCHEDULE

✓ BELOW GUARANTEED COST



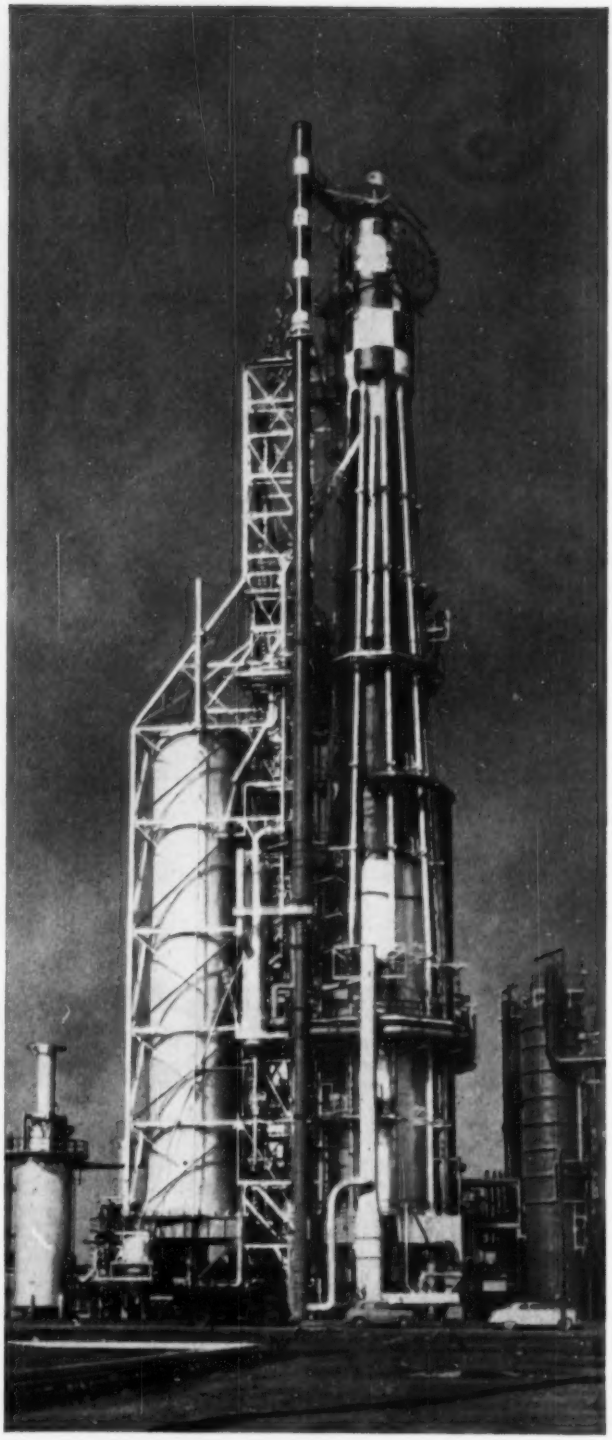
On July 30, 1955, Lummus turned over to Canadian Petrofina, Ltd., the 16,000 BSD Houdriflow Catalytic Cracking Unit and the 3,000 BSD Hydrodesulfurization Unit built at their new Point Aux Trembles Refinery near Montreal.

Construction on these two units began late in April, 1954, with the client requesting that the plant be completed by September 1, 1955. Substantially ahead of schedule by March, 1955, Lummus and the client agreed to use an absolute minimum of overtime labor for the remainder of the project to allow simultaneous completion of other refinery facilities. Even so, the two units were completed ahead of schedule, at a cost below the original guaranteed maximum.

Lummus constructed the Catalytic Cracking Unit complete with a charge heater system, Fractionation Unit, and Vapor Recovery Unit. The Hydrodesulfurization Unit (built under Shell license) is the second of these units in the world (Lummus having completed the first at Stanlow, England early in 1955). An outstanding feature of these units is the electronic instrumentation for temperatures, pressures and flow rates, complete with digital indication and adapted to automatic print-out logging and graphic panels. This is the first electronically instrumented Catalytic Cracking Unit in this hemisphere.

Lummus engineers can save time and cut costs for you on your next project.

THE LUMMUS COMPANY CANADA LIMITED, 455 Craig St. W., Montreal, Que. *Engineering and Sales Offices:* New York, London, Houston, Bombay, Paris, The Hague. *Sales Offices:* Chicago, Caracas. *Heat Exchanger Plant:* Honesdale, Pa. *Fabricating Piping Plant:* East Chicago, Ind. Licensed Manufacturers of Heat Transfer Equipment throughout Canada.



16,000 BSD Houdriflow Catalytic Cracking Unit

# LUMMUS

DESIGNING ENGINEERS AND CONSTRUCTORS FOR THE PETROLEUM AND CHEMICAL INDUSTRIES

As Management Sees It . . .

# Accounting is an Effective Maintenance Tool

**Jackson D. Leonard**
Brown, Blauvelt & Leonard
New York

WHILE SIMPLIFIED accounting reports and procedures are widely used by production supervisors for cost control, there are few plants that use any type of accounting report or procedure for maintenance cost control. Why should this be?

To develop the answer, we need to look first at the basic attitudes of the maintenance and accounting people.

Maintenance supervision is invariably suspicious and distrustful of the figures supplied by the average accounting department, and understandably so. Since the accounting department is primarily interested in determining over-all costs and profits, they accumulate and consolidate cost figures of a similar nature and eventually arrive at a single lump sum figure representing the total cost of maintenance labor and material for a month.

And while this figure is quite suitable and satisfactory for accounting purposes, it is of little value for control of maintenance costs.

On the other hand, accounting people seldom understand the problems of the maintenance supervisor and tend to be rather uncooperative, and resistant to requests for cost information from maintenance supervision.

In some cases, the accountants have real cause for being reluctant to furnish detailed figures of any type because of the practice of "burying" capital expenditures in maintenance costs in order to write off such costs as expenses, and reduce the federal income tax liabilities.

But, in most cases, it is simple failure of the maintenance supervisor to make known his needs to the accounting department, and failure of the accountant to realize that maintenance, like operations, must have simple figures of certain types available throughout each month in order to exercise adequate cost control.

Secondly, it is usually true that maintenance supervision has been made extremely "cost sensitive" by repeated haranguing of today's cost conscious managements, but in few cases, have they been given training in how to do a good cost control job. The usual procedure involves a direct frontal assault by management upon maintenance supervision, during the course of which the directive to "get those maintenance costs down by 10 percent next month or else" is the usual ultimatum.

Maintenance supervision very often has so little cost information available that they have little real knowledge of why or how their costs are out of line, or actually, whether they really are excessive or not, and thus, take the only action they can take, and lay off enough maintenance personnel to effect the desired reduction.

Third, and perhaps of chief importance, is the fact that management has paid the price to obtain methods for production incentives, production cost control, production product control, etc., but they have not been generally willing to pay this price to develop similar methods to streamline, improve, and control maintenance.

Having operated in the chemical industry as a maintenance consultant, the writer can personally verify the correctness of this statement, along with the further observation that in most plants, simple accounting controls that will assist maintenance supervision and management equally, can be established at relatively small cost, and can yield substantial returns.

The chief purpose here will be to outline methods of accounting control and procedure that can be readily adapted and have proven satisfactory in achieving maintenance cost control.

In considering such methods, maintenance supervision should remember that there are two aspects of good control. First, the over-all maintenance cost; and secondly, individual job costs, and equipment costs.

So far as over-all costs are concerned, adequate control figures can be furnished by the accounting department without any great expenditure of time or effort on their part—but they must be instructed in the figures that are needed.

**Weekly Time Reports**—Of chief importance, is to have weekly repair labor hours of each maintenance crew reported by daily totals and all overtime hours shown. Such information can be accumulated daily by the plant time keeper, and reported to each maintenance foreman on simple mimeographed forms in pencil, once each week.

With such information, the main-

## Meet the Author

JACKSON D. LEONARD, for the past six years a consultant in New York, has handled design work, not only in the U. S., but in Europe and the Far East. A partner in the firm of Brown, Blauvelt and Leonard, he specializes in chemical processes and chemical-plant maintenance. Before entering the consulting field, Leonard served three years with Allied Chemical & Dye Corporation and ten years with E. I. du Pont de Nemours & Company. He is a chemical-engineering graduate from Pennsylvania State University.

Leonard

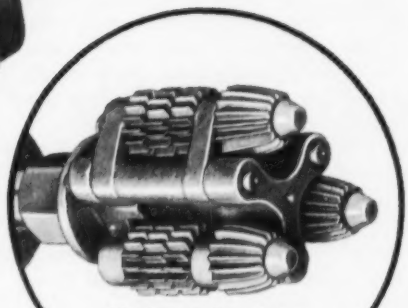
**Accounting methods cannot substitute for a good maintenance supervisor . . . but here's what they can do:**

- **Help supervisors do a better and more efficient job.**
- **Provide management with up-to-the-minute details of maintenance cost.**
- **Give management reasons for deviations in maintenance cost.**

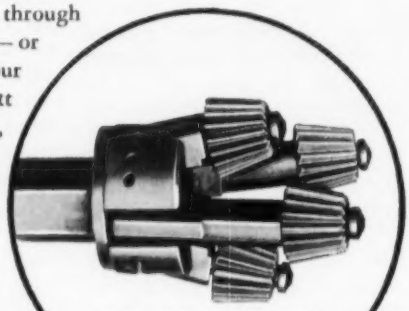
clean-outs go fast with LAGONDA

The famous Lagonda 1100 Series refinery motor, with Type UO cutter head. A popular combination.

YOU'LL BE BACK ON STREAM in record breaking time when these rugged Lagonda tube cleaners get on the job. Naturally it's important you have the right super-hard cutter head and 1100 Series motor for your particular coke application. Call in your local Lagonda man to look over the situation; he'll gladly recommend a fast-cutting unit that will zip through coke in a jiffy. Contact him — or write us direct in time for your next clean-out. Address Elliott Company, Lagonda Division, Springfield, Ohio.



The long-surface Swing frame head—designed for wide tolerance tubes.



The type H-2 head — a favorite for tough, uneven coke.

Catalyst Cleaner — tops for removing spent catalyst from tubes and piping it away.

ELLIOTT Company

YS-5A

STEAM TURBINES • MOTORS • GENERATORS • DEAERATING HEATERS • EJECTORS • CONDENSERS • CENTRIFUGAL COMPRESSORS • TURBOCHARGERS • TUBE CLEANERS • STRAINERS


## As Management Sees It . . .

tenance supervisor can each week take a few minutes to note:

**1.** Whether total shown is correct or not, as it is quite possible for the time keepers (or the foreman himself) to make errors;

**2.** Note the reason for all overtime hours while such reasons are still fresh in his mind;

**3.** Note on the same form any large number of repair hours on any one job.

**Weekly Repair Material Reports**—In the same way, accounting can provide the weekly repair material totals to each maintenance foreman, and thus give him the opportunity to note large or unusual charges and investigate the reason for them while they are still fresh.

While such information is "after the fact," a large part of cost control effort can be better focused and guided if the correct reasons for deviations are known. It is also considerably easier to inform management at the end of the month, why costs are high, normal, or low if such weekly check information is available from each maintenance foreman.

**Job Costs**—But the real job of cost control has to be done while repair jobs are in progress and not afterward, and the only way to accomplish this control, is by the accumulation of repair labor and repair material charges against each work order as it is being performed each day.

It is in this area that the accounting department usually declares that such information does not serve direct plant accounting purposes, and such accounting must be performed by maintenance personnel. And usually, such accounting is performed by a "maintenance clerk" rather than by accounting personnel.

Assuming that a work order system is in operation, and job time cards are being used by each maintenance worker, then for an average maintenance department of 100 men, one maintenance clerk can in four hours time each day accumulate labor charges against each repair order from the previous day's time cards, and accumulate repair material charges from the previous day's stores tickets.

Maintenance supervision can then see at a glance, the total labor hours, and material charges against each job

PETROLEUM CHEMICALS DIVISION
# NEWS

January ★ One of a Series of Interest to the Petroleum Industry ★ 1956

## QUESTION BOX

1. WHAT is the *"typical"* American service station operator's reaction to price wars?
(see article at right)
2. WHERE can you look for new program ideas for your next dealer meeting?
(see below)
3. WHOM can you contact for technical service in the Gulf Coast Region?
(see next page)
4. HOW can you prevent *gel-clogged* heating oil lines?
(see next page)

**ANOTHER DU PONT MARKETING SERVICE**

### Wide selection of program aids available for dealer meetings

During recent years, a wide variety of sales promotion aids have been developed by the Du Pont Petroleum Chemicals Division. These are all designed to be readily adaptable by any oil company for use in its own marketing program. And they make ideal program material for dealer meetings.

A new movie, "When the customer says 'KNOCK,'" is one example of the material available. This explains the common causes of knock other than gasoline quality and helps your dealers answer customer complaints in a salesmanlike way. You can follow up this film with a series of cartoon booklets that will help the dealers remember its message.

Another unique film presentation showing dealers how they can easily *sell themselves* is narrated by an animated cash register. And there are flannelboard presentations on gasoline and lubricating oil quality. Chassis dynamometer and single-cylinder engine demonstrations are also included. For special programs, you can even arrange to use the Du Pont fleet of fuel test cars.

For more information on these and other dealer meeting aids, just get in touch with any of our sales offices. Ask for a copy of "Sales Promotional Aids for Dealer Meetings."

# WHO is your "typical" dealer... and HOW does he operate?

***Many important facts about the man and his business are revealed in Report No. 4 of Du Pont's continuing market survey, "The Service Station Operator"***

Thousands of customers form, confirm, or change their opinions of your company every day . . . based on the impressions made by your service station operators. Because of this, a composite, cross-section picture of the average dealer can be valuable to you in formulating dealer policies and sales promotion plans.

**"The Service Station Operator"** is a new Du Pont survey designed to give you a clear, concise picture of the average American dealer . . . his employees, his business, his opinions, his background, his relation to his petroleum products supplier, and his motivations. Three reports on this survey have already been published and made available to marketers by the Du Pont Petroleum Chemicals Division.

They cover (1) such dealer retail functions as station hours, gallonage, credit and mailing lists; (2) dealer knowledge of products, additives, sales assets, and prices; and (3) opinions on dealer meetings, advertising, dealer publications, and sales aids.

**Report No. 4**

The fourth report in the series, which has just recently come off the press, discusses the dealer's relationship with employees, his income and reactions to price wars, and his interests in dealer association activities.

The statistics included in the report are graphically illustrated with charts and are enlivened by cartoon drawings. This format makes the important points easy to reach, remember, and refer to.

**What happens when . . .**

For example, how does the average dealer react to a price war in his own marketing area? That is one of the factors influencing your business which is covered in Report No. 4.

Most of the dealers who have experienced price wars, the survey found, encountered them within the past year. What did they do? . . . The biggest percentage of them met the competition by cutting their own prices. A number of them, however, decided to hold out and refused to cut their prices. Other interesting reactions are also tabulated in this survey report.

*ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)*

OVER

DU PONT

PETROLEUM CHEMICALS DIVISION
NEWS

DU PONT

CONTINUED *"Dealer Survey"*

**What's next?**

A fifth report on "The Service Station Operator" survey is due to be published soon. This will be the most significant of the whole series of reports. It will discuss the interrelationships of all the factors covered in previous reports . . . such as how dealer meetings, station hours, price wars, and other variables affect sales volume.

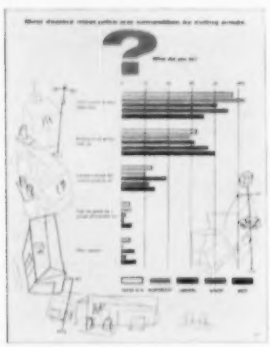
As part of the continuing market research work of the Du Pont Petroleum Chemicals Division, this dealer survey is the natural follow-up of an earlier survey on the buying habits of consumers at service stations. The interviews were conducted on a completely impartial basis by National Analysts, Inc.

**Specialized cross-tabulations**

Based on personal interviews with 2,633 service station operators – selected by the scientifically accurate area-sampling method – the survey is representative of all the operators in the United States. But the results can be broken down and cross-tabulated to give a true sample of any of four geographical areas.

And in addition to the regular distribution of reports to marketing executives, the entire survey has been tabulated on IBM cards, which will give a wide variety of specialized breakdowns to meet the individual needs of various oil companies.

For more information about this survey, just get in touch with any of our sales offices listed below.



HERE IS a typical page from Report No. 4 on "The Service Station Operator."

## GULF COAST REGIONAL LAB MANAGER

**John N. C. Cameron,** manager of the Du Pont Petroleum Chemicals Division's regional laboratory in Houston, Texas, is in charge of customer service, product testing and additives treating recommendations for Du Pont customers in the Gulf Coast Region.

Before joining the Du Pont Company in 1949, Mr. Cameron was with the Research and Development Division of Humble Oil and Refining Company at Baytown, Texas. During his seven years with this company he worked as a research chemist on octane rating and light oil analytical research. He also did pilot scale research on catalytic treating. Prior to his assignment at Humble, he was employed for three years by the Gravity Meter Exploration Company in Houston.

After starting his college career at the University of Texas, he transferred to the University of Houston, where he received his B.S. degree in chemistry.

Mr. Cameron is a member of the American Chemical Society.

## Gel-Clogged Heating Fuel Line!

### *. . . you can avoid this complaint*

A rash of clogged fuel line complaints can quickly jockey you into some rather embarrassing situations. On the other hand, you can easily avoid this kind of trouble before it starts.

If the fuel oil is at fault, the clogging generally occurs in the line leading from the fuel oil storage tank to the burner, or at the screen ahead of the fuel pump. This clogging is generally due to the formation of a *gelatinous* material. And copper or brass are the culprits.

Since the feed-in line and the screen are often made of copper alloys, these are a potential source of copper mercaptides. If formed in sufficient quantities, the mercaptides become gelatinous in nature. So to prevent the clogging you must protect your fuel against the harmful effects of copper.

**Here's how . . .**

You can help assure adequate protection with DMD (Du Pont Metal Deactivator). It is highly effective in most fuel oil stocks in low concentrations (about 2 pounds per 1000 barrels).

This means that you can, in most cases, insure yourself against the harmful effects of copper—and promote better customer relations, too—at a cost of *less than ½ cent per barrel.*

For best results, it is recommended that you use DMD in combination with Du Pont Fuel Oil Additive No. 2 which guards against sludge.

**THIS BOOKLET** describes the properties, uses, and methods of addition of DMD. If you do not have a copy, any of our sales offices listed below will be glad to send you one.

DU PONT

Better Things for Better Living
*. . . through Chemistry*

# Petroleum Chemicals

**E. I. DU PONT DE NEMOURS & COMPANY (INC.)** *Petroleum Chemicals Division* • *Wilmington 98, Delaware*

**Sales Offices:**

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NEW YORK, N. Y.—1270 Ave. of the Americas Phone COlumbus 5-2342
PHILADELPHIA, PA.—3 Penn Center Plaza Phone LOcust 8-3531
PITTSBURGH, PA.—Room 510, Alcoa Bldg. Phone ATlantic 1-2933
SAN FRANCISCO, CAL.—Room 626, 111 Sutter St. Phone EXbrook 2-6230
SEATTLE, WASH.—Room 215, 4003 Aurora Ave. Phone MElrose 6977
TULSA, OKLA.—P. O. Box 730 Phone LUther 5-5578

IN CANADA: Du Pont Company of Canada Limited—Petroleum Chemicals Division—80 Richmond Street West—Toronto 1, Ontario
OTHER COUNTRIES: Petroleum Chemicals Export—Nemours Bldg., 6539—Wilmington 98, Delaware

*ADVERTISEMENT—Prepared for the Petroleum Chemicals Division of E. I. du Pont de Nemours & Company (Inc.)*

A-633

Printed in U. S. A.

while it is in progress, and steps can be taken to limit or control the costs on any one job.

This "in process" type of cost control can be a real weapon in preventing large jobs from running over estimates, and getting out-of-hand.

**Equipment Costs**—However, of equal value is the fact that these accumulated labor and material charges on each completed work order can be entered on a cost card that can be established for each piece of plant equipment. Then at the end of each six-months period, the total cost of maintaining each building, and each piece of plant equipment can be accurately determined. With such information available, a good maintenance engineer can perform individual "case studies" to replace or modify equipment that is costly to maintain. In some cases, he can begin process studies that can sometimes alter, modify, or change process conditions in order to reduce maintenance on certain equipment.

The value of job costs and equipment costs have been proven in many plants. Studies have shown that there is ample justification for the expense of gathering these costs.

But while the value of such accounting has been recognized, the methods employed often are costly and far too complicated. One plant that went into an extensive maintenance program, wound up installing a very expensive battery of punch card machines and operators to accumulate job and equipment costs. This information could have been accumulated by 1½ full time clerks, aided by a few simple pieces of inexpensive equipment such as a card file system, and six post files.

In plants that complain of the cost of such accounting, it is usually found that little attention is given to the work place of the maintenance clerk, or the equipment he is given to work with. When the clerk's work place is arranged properly, and equipped properly, it is easy for one clerk to accumulate job costs for a 100-man maintenance department, enter completed job costs on equipment cost cards, and still have time left to help order maintenance material, and perform other odd jobs.


NOW YOU CAN SPECIFY STANDARD R-S BUTTERFLY VALVES FOR FASTER DELIVERY

R-S BUTTERFLY VALVES

When the delivery date is important, you can get faster service on standard R-S Butterfly Valves. Based on the results of previous experience, R-S Valves are now standardized. All components for those most commonly used, in sizes from 4" to 48", are carried in stock, ready for assembly.

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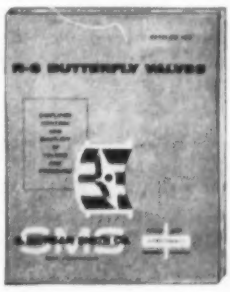


**This new catalog** will give you complete dimensions, specifications, layout drawings and materials for all R-S Butterfly Valves in the pressure ratings that have been standardized to date. As others are added, new sections will be published. To get a free copy and assure yourself of future sections, contact your SMS representative, or write to S. Morgan Smith Company, York, Pennsylvania.

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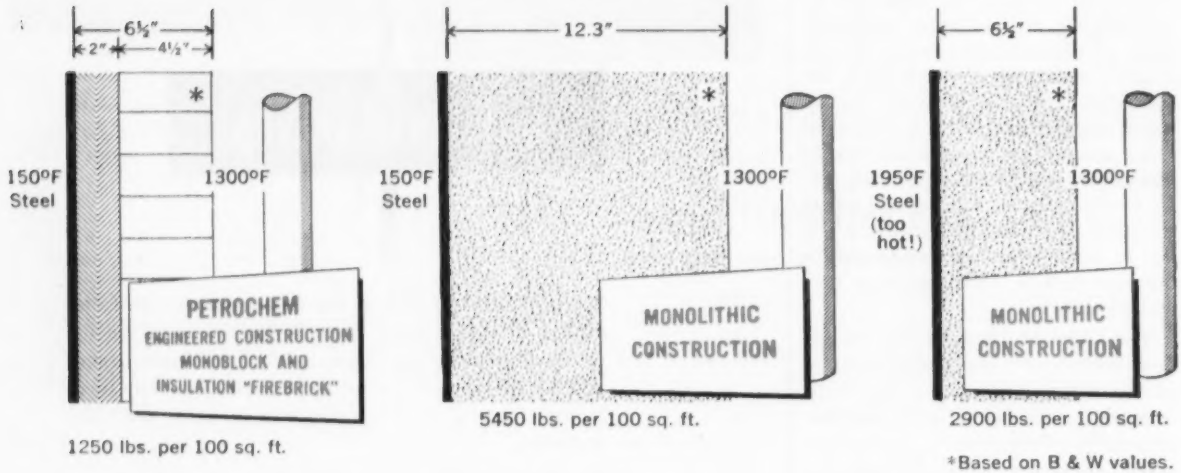
# In furnaces as in processes compare the design to judge the advantages

As an example:

The wall construction of all Petrochem-Isoflow Furnaces is designed for 150°F maximum outside shell temperature.




1250 lbs. per 100 sq. ft.

5450 lbs. per 100 sq. ft.

2900 lbs. per 100 sq. ft.

*Based on B & W values.

The Petro-Chem design provides a thoroughly engineered wall construction. It is built with two tiers of monoblock supported on 18 inch centers and a circular arched wall of insulating firebrick. The inside of the steel shell is protected from the possibility of corrosion by a one-eighth inch thickness of Staylastic cement. This type of construction, independently supported monoblock and the circular arch of firebrick, bonded with Smoothset mortar, assures optimum efficiency and minimum maintenance.

The use of monoblock and insulating firebrick laid as a circular arch provides many advantages over a one-piece monolithic lining, including:

*1—Low weight, 2—Low heat conductivity, 3—High hot crushing strength, 4—Low expansion coefficient, 5—Resilient compressible backing, 6—Long life, 7—Nil maintenance.*

Also, this construction has low heat storage capacity, speeds both heating and cooling. Its light weight requires less concrete foundations and steel supports.

Compare and your judgment will affirm
Petrochem-Isoflow Furnaces are Most Efficient by any Comparison

**PETROCHEM-ISOFLOW FURNACES**

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As Management Sees It . . .

# Disaster Brought About Improved Human Relations

**R. W. Callahan**
Monsanto Chemical Company,
Texas City, Texas

OUT OF THE Texas City holocaust of April 16, 1947, has grown an expanded Monsanto Chemical Company plant. From the tangled debris and shattered organization of the 1947 explosion has grown a plant nearly four times as large—both physically and personnel-wise.

Visitors are amazed at the rebuilt and enlarged facilities at Texas City. But one cannot weigh as easily the expanded human values that exist in the plant.

Human relations are more than a "topic for discussion" at Monsanto's plant. They are a vital, dynamic, vigorous part of the every-day life. Although imperfect and changeable, they are always challenging.

Human relations in maintenance at Texas City cannot be divorced from over-all company policy. The subject is approached from three different angles: (1) the individual, (2) the group, and (3) the civic interest field of endeavor. Many widely-used methods are employed for furthering human relations, but Monsanto feels that its greatest achievement has been the sincere teamwork that was an outgrowth of the dark days of the explosion. The "oldtimers" formed an inspiring team during these reconstruction days, led by H. K. (Griz) Eckert, then plant manager. Their spirit of loyalty, unselfishness, and cooperation still dominates the friendly atmosphere which is so essential to good human relations.

On the individual level this friendliness is perhaps our most valuable asset. All personnel feel the impact of the sincere interest in each person by his fellow associates. This natural unaffected concern for the individual has developed a "family pride" for our company, our plant, and our fellow humans. This feeling is common to all levels of the maintenance force and is confined to none. Within this climate many otherwise "routine" human relations programs have taken on a new meaning.

All persons enjoy the benefit of first rate programs covering the areas of medical treatment, safety, sick leave, insurance, retirement and vacation. The personnel department is unusually thorough about indoctrinating new employees and the company has comprehensive training periods which are augmented by considerable individual attention by the supervisors.

The hourly maintenance worker is encouraged to advance and the majority of promotions are made from the ranks. Apprentice training programs are in effect for most crafts and on the job training is stressed. The craftsmen are rotated about the various areas as frequently as practicable to broaden their specific experience.

Personal safety equipment is supplied to each individual and special clothing, tools, etc. are supplied where needed. Personal lockers, tools, rain gear, and work benches are provided by the company. Each man is kept well informed of all plant and company affairs by magazines, bulletins, letters and group meetings.

A clearly defined grievance procedure insures the employe of a fair and early decision on any complaint. When requested to work overtime all personnel are furnished meals at the appropriate times and where necessary are supplied a ride home by the company.

The maintenance supervisor has all the usual benefits and privileges. In addition, he has many other opportunities to improve himself. Individual counseling and coaching interviews are held at least once a year for every supervisor. His entire career is discussed and reviewed to aid him in advancement and self improvement. All members of maintenance supervision attend the "Human Relations Institute of Management" at Southern Methodist University, Dallas.

The company encourages attendance at various technical meetings and pays the expenses of the employe. Individuals are sent to the Annual Plant Maintenance Show each year and to other meetings of interest to maintenance. Supervisors serve on various committees and conduct group meetings such as safety programs which help broaden their experience.

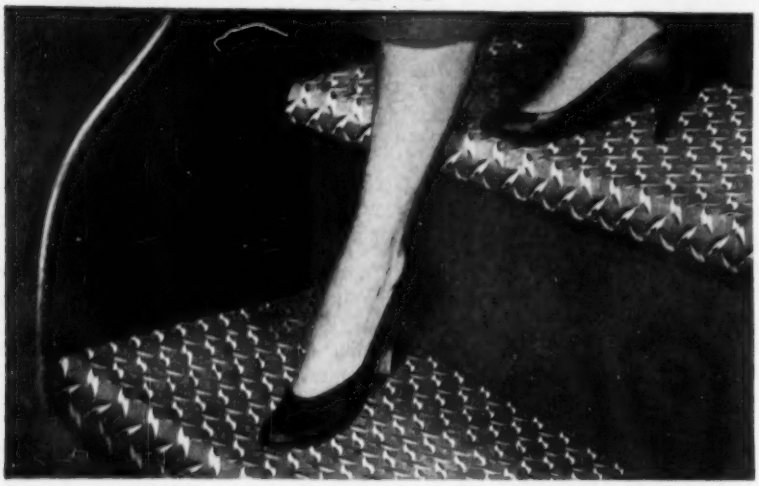
Each individual is encouraged to handle special assignments and assume maximum responsibility to prepare for a higher position. The maintenance supervisor is kept well-informed at all times and is supplied with the staff services he needs in any phase of his work. Special manuals and data are at his disposal and he can have as broad an outlook as his capabilities will permit.

This individual attention produces men of all positions who are willing to work "above and beyond" their routine tasks willingly whenever circumstances require it. For example, the case of an electrical maintenance man who worked until 2 a.m. and went home. After getting home he realized that he had disconnected the wiring inside a switch in a plant breaker room to make a motor repair and had forgotten to replace them. He returned on his own time, reconnected the wiring, and went home without asking for any remuneration. This spirit of loyalty has saved time,

**Meet the Author**

ROBERT W. CALLAHAN supervises the maintenance of oxygen, acetylene and waste-disposal plants for Monsanto Chemical Company in Texas City, Texas. Before joining the company in 1951, Callahan was a refinery operator in thermal cracking with Union Oil Company of California. His background also includes several years as a construction superintendent with Chemical Construction Corporation.

**Spikes reduce slipping on ball diamonds,**



**but ordinary shoes are SAFE SHOES**

**on low cost A.W. SUPER-DIAMOND**

***ECONOMY ROLLED STEEL FLOOR PLATE***

Ordinary flat-soled shoes—rolling stock, too—move safely over SUPER-DIAMOND's traction treads—from any angle of approach. The raised diamond pattern—40 steel diamonds to the step—has been exclusively designed and engineered for maximum foot safety at minimum cost.

*No other floor plate can match* A.W. SUPER-DIAMOND *for safety, durability and easy maintenance at so low a cost.* Write for detailed information.

- **No matching problems**
- **Fast installation**
- **Easily fabricated**
- **Cleans, drains rapidly**
- **Takes years of abuse**

**A.W. SUPER-DIAMOND**

**ROLLED STEEL FLOOR PLATE**

*"The diamond in the rough . . . a gem of a flooring."*

**ALAN WOOD STEEL COMPANY**

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Other products: A.W. ALGRIP Abrasive Rolled Steel Floor Plate—Plates—Sheets—Strip—(Alloy and Special Grades)

For plants where oil, water and grease raise special problems of slipping accidents, we suggest a check on the special qualities of A.W. ALGRIP . . . the world's only abrasive rolled steel flooring.


## As Management Sees It . . .

money and delays in countless instances.

A weekly meeting is held by the maintenance superintendent with all supervisors to discuss departmental problems and exchange information. Group safety meetings are held at least once a month. Special meetings are conducted to cover unusual problems which concern only specific groups.

Group sports are encouraged such as departmental baseball, bowling, golf and tennis teams. An employe social club conducts various dances, picnics, and outings and operates a store for the benefit of the group.

Plant management and plant union committees meet weekly to discuss problems concerning the plant as a whole. Both hourly and supervisory maintenance personnel are well represented on these committees.

The maintenance department has a well trained and organized volunteer fire crew which works with other groups in an emergency.

But above all, the maintenance group is a "shirt sleeve" organization which operates as an informal team and most members know each other by their first names. "The office" is always open to anyone and this encourages co-operation through all levels of the organization. During turnarounds and emergencies the teamwork is notably high and everyone is willing to pitch in for the common good. As a group the maintenance men are unusually helpful in aiding new employes or men promoted to greater responsibilities, get established in their new jobs.

Recently a much needed plant was forced to shut down unexpectedly. The work normally requires 96 hours to complete from a maintenance viewpoint. The word was passed verbally throughout the organization that this unit was a "hot job" and to save all time possible in the maintenance downtime. In cold rainy weather the typical sized crew raced against the clock on a 24 hour day and returned the plant to production 36 hours ahead of schedule. A job of this scope could not be "driven ahead"—the difference was that elusive morale and co-operation we all hope for when we talk of human relations.

This group and individual effort

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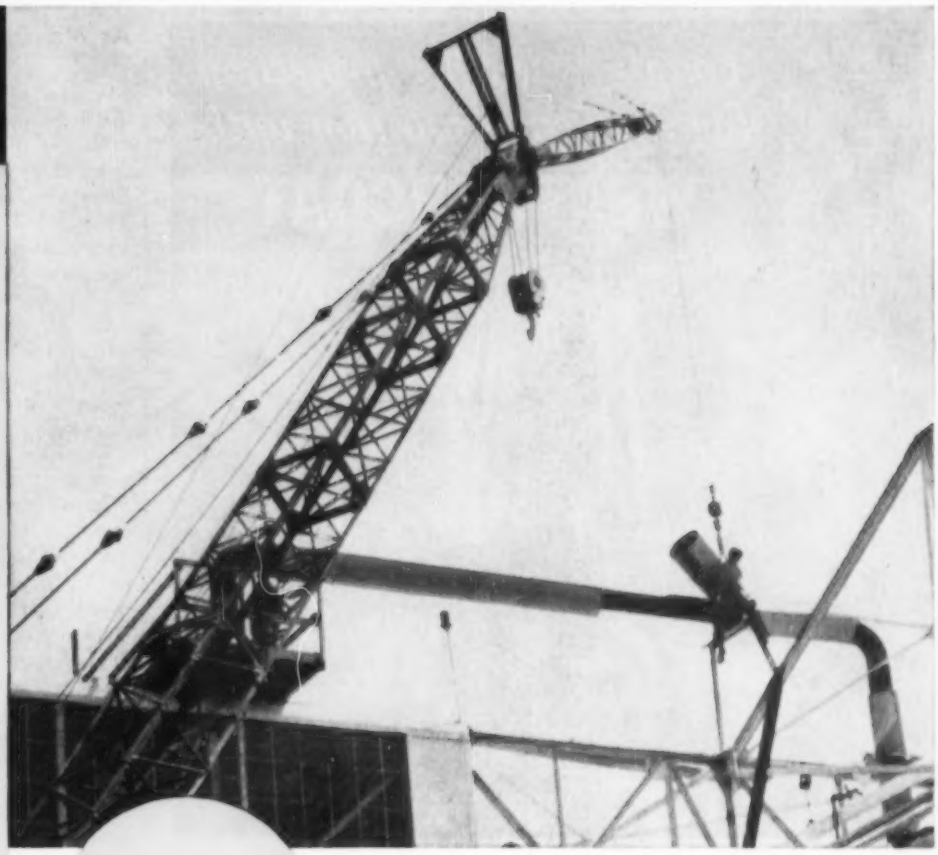

# Anyone can apply SNAP*ON anywhere!

*Versatile* is the word for G-B Snap*On, the new one-piece pipe insulation molded of fine glass fibers. Whether you need pipe insulation for hot or cold piping, in the plant or outside, in ¾" to 33" sizes, Snap*On is the pipe covering for you. Anyone can handle this new lightweight and indestructible insulation . . . anyone can apply it by simply spreading the single seam and snapping the material over the pipe.

As the photo indicates, if you can put a man in contact with a run of pipe, he can quickly insulate it all by himself with Snap*On. The one-piece construction of Snap*On reduces labor cost of installation one-third, in many cases. Waste is nil, even though plant workmen have never used the product before nor received any special training in its application.

If you can't say as much for your present pipe insulation, call your nearby Snap*On distributor whose phone number is shown in the adjoining column. He'll furnish you samples and complete technical data that will prove to you that for thermal efficiency, low-cost application, and permanence, there's nothing like G-B Snap*On. Call him today.

## GUSTIN-BACON *Manufacturing Company*

Thermal and acoustical glass fiber insulations • Pipe couplings and fittings • Molded glass fiber pipe insulation

**242 W. 10th St., Kansas City, Mo.**



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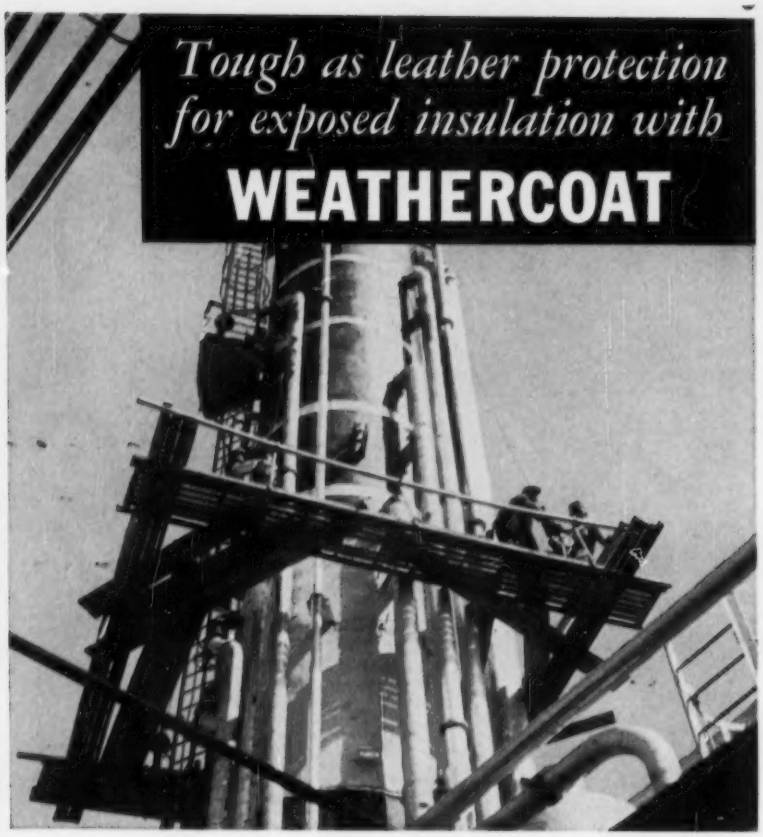


## . . . the asphaltic coating that stays "ALIVE"

**Thermal insulation on outdoor operating facilities needs a "raincoat." This material depends upon small air spaces formed by the flake fibers, or spheres of solids in the insulation itself to retard the flow of heat (or cold). Should moisture fill all or part of these air spaces the efficiency of the insulation would be seriously affected.**

**Weathercoat gives lasting protection.** Weathercoat has an extremely high resistance to moisture in all its forms. (It has a Perm rating of 0.0175 for 0.10" thick dry film.) It is a factory compound of asphalt emulsion and mineral fillers and fibers that sets to a smooth, tough and pliable finish. Because no clays or other hydrophilic fillers are used in Weathercoat, it stays "alive." This assures long-lasting protection for insulated surfaces.

**Nation-wide acceptance.** Many of the largest refineries, chemical plants, and power stations in the nation are regular users of Weathercoat, both for maintenance and for new construction. During the last year alone, over 5 million sq. ft. of insulation have been coated with Weathercoat. The Laykold Engineer in our office nearest you will supply full details.

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San Juan 23, P.R.


## As Management Sees It . . .

has produced better relations with other departments. Although we naturally have our disagreements the general spirit of putting the job first has prevailed with great benefits. Throughout our rapid expansion we have managed to meet extreme demands on personnel and still retain the essence of teamwork which has been the keynote of this plants' human relations program. This same friendly climate is one of the major reasons for our exceptionally low turnover of personnel, which is of great value to a company that needs trained men.

Like most maintenance departments we never seem to have enough men, tools, or time and never run out of jobs. In spite of the constant pressure to meet schedules and man emergencies the department always manages to solve the problem and takes a fierce pride in doing so.

For a city with 25,000 population Texas City is blessed in many ways. Due to the large modern plants and the income derived from them the city has above average financial resources. But even more important is the wealth of the cosmopolitan people from all parts of the world who participate so enthusiastically in civic affairs.

Monsanto maintenance personnel are prominent in community activity.

With Company policy encouraging them, Monsanto people are able to devote the time and effort to be successful in any worthwhile civic venture.

It is felt that all our neighbors in industry can match the physical facilities and the human relations programs offered at Monsanto. However, it is believed that the greatest challenge to all industry is in the field of human relations and we are proud of the excellent beginning which we have had at Texas City. The company has its gripes, debates, differences of opinion, and rough spots like any large group of humans but realize that time, patience, and increased skill in working together will produce great rewards.

Living up to a good human relations program such as the Maintenance department offers is somewhat like abiding by the Ten Commandments; it is impossible to be perfect but is fun trying. ##


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# *Here's Why You'll Want a Copy of the*

## *NEW* GMXD COMPRESSOR BULLETIN

● If you have a stake in compressor operation, or are interested in learning more about the latest developments in compressor efficiency and economy in the 265 to 660 horsepower range, merely complete and mail the coupon below. You'll receive the brand new Cooper-Bessemer GMXD bulletin.

This 20-page bulletin describes the latest cost-cutting developments in V-angle engine-driven compressor design and construction — developments that mean improved fuel economy, greater capacity and broader practical application.

Other features of the bulletin include detailed cross-sectional diagrams, space plans, typical installations, specifications, operational advantages, and complete information on GMXD *packaged* units.

Learn for yourself how these Cooper-Bessemer advantages are paying off in field gathering, in refineries, and petrochemical operations. Request your copy today.

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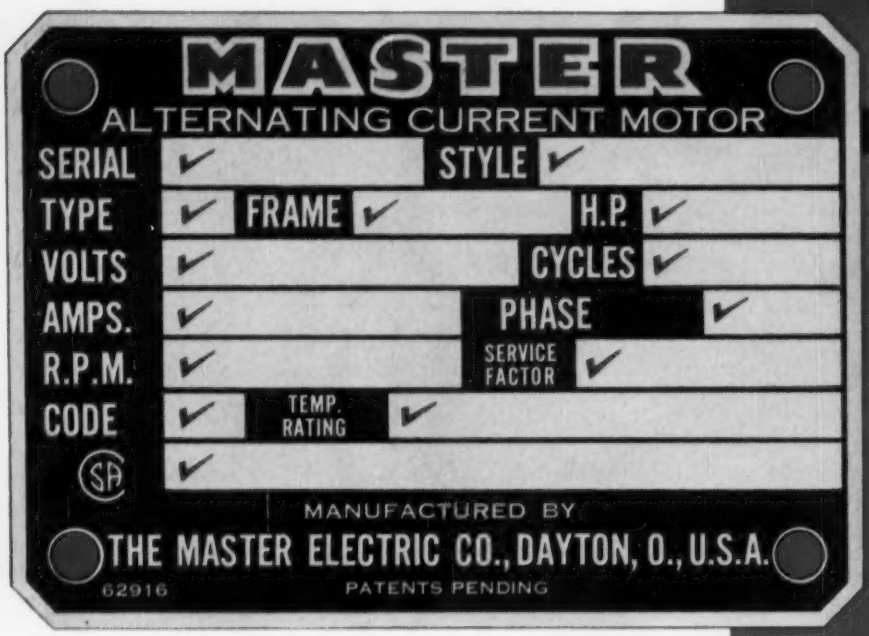


What are your power drive requirements? Here at Master, with the widest selection in the nation to choose from, you're sure to fill your needs quickest and best.

Need something special in gear reduction—electric brakes—variable speed operation—fluid drive or special mounting? Or would some of our standard models (⅛ to 400 H.P.) fill the bill? You'll find the answer here! And remember, all Master components are engineered to form combinations of units in one streamlined, compact package of efficiency. Name your need and the name that fills it is Master—for greater salability of motor driven products; for increased productivity of plant equipment.

**Motor Ratings**..⅛ to 400 H.P. All phases, voltages and frequencies.

**Motor Types**.....Squirrel cage, slip ring, synchronous, repulsion-start induction, capacitor, direct current.

**Construction** ....Open, enclosed, splash-proof, fan-cooled, explosion-proof, special purpose.

**Speeds** .....Single speed, multi-speed, and variable speed.

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**Power Drive Features** .....Electric brakes (2 types)— 5 types of gear reduction up to 432 to 1 ratio. Mechanically and electronically-controlled variable speed units—fluid drives—every type of mounting.

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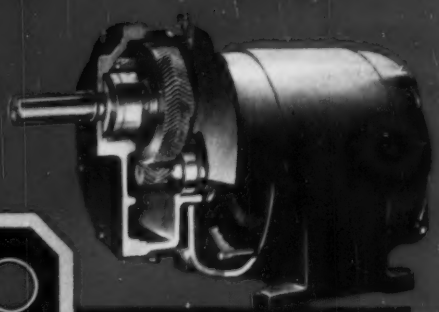
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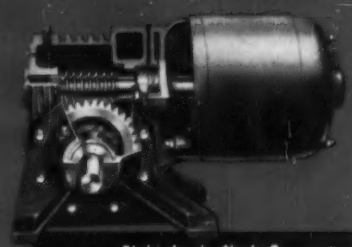
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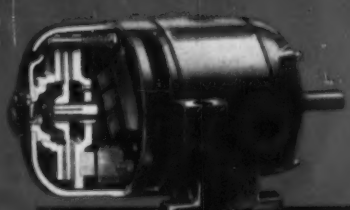
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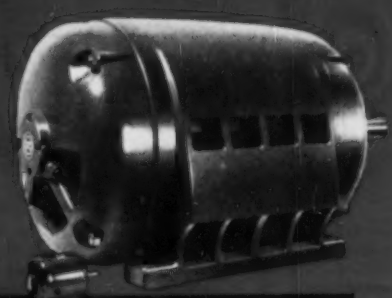

Standard Motors— ⅛ to 400 H.P.

As Management Sees It . . .

Formula for smooth . . .

# Operations-Maintenance Coordination

**Closer cooperation between the Operations and Maintenance departments is the goal of every company. Here's how Brea Chemical solved it.**

**Harry E. Kinsella**
Brea Chemicals, Inc.
Brea, Calif.

A GOOD TEAM, well grounded in fundamentals, is the key to smooth Operations Maintenance relations.

Here are the essentials of the system used by Brea Chemicals, Inc., at the Brea plant in California.

- Employes well schooled in departmental objectives, responsibilities and authorities.
- Centralized interdepartmental contacts. Two operations co-ordinators and the maintenance planner determine job priorities—jointly plan synchronized activities—strive to have scheduled maintenance repairs accomplished as planned—and adjust job priorities to accommodate the master operating plan.
- Streamlined methods and procedures.
- Periodic review of interdepartmental relations.

Following is a discussion of the cardinal points in this Operations-Maintenance plan:

**Common Objective**—Each employe in the departments must be aware of the prime purpose of the Manufacturing department, i.e. to obtain the maximum production possible with the basic existing facilities at the lowest cost consistent with Company standards of safety, workmanship and materials.

**Define Authority**—The Operations department is the recognized "hub" of the plant organization and the Engineering & Maintenance department acts in a service capacity.

The Operations department has full responsibility for facilities within it's jurisdiction. Any request for work on these facilities by any department must be approved by authorized operating personnel.

Operations instructs what is to be done and the Engineering and Maintenance department determines how the work is to be accomplished and is held accountable for the job expenditures.

Operations determines the priority of maintenance work requests. The maintenance section does the work when requested or advises Operations why the job cannot proceed and requests a change in its priority.

It is the responsibility of the Operations department to isolate the process equipment and/or piping and prepare same for the maintenance crews in advance of scheduled job starting times.

The Maintenance section determines when repair work is completed from the standpoint of workmanship and materials and is held accountable for unnecessary delays in the work schedule and the quality of the repair job.

Safety is the responsibility of every employee.

Operations and Maintenance collaborate in establishing lists of blanks required for the various repair jobs.

Operations initiates plan sheets required for "hot work" (welding, and vessel entry). Hot work is used only as a last resort, i.e. when the equipment or piping cannot be isolated and removed for work in an "open" area.

The Safety and Maintenance departments approve all "hot work" plan sheets.

Work request must be signed by the operator when he releases equipment to a maintenance crew. The maintenance mechanic must indicate his acceptance of the equipment as safe to work on by also signing the work order. Maintenance can refuse to work on any job where safety of their personnel or plant equipment is in question.

**Organizations, Methods & Procedures.** Two operations coordinators (former Shift Supervisors) screen all routine work requests originating in the areas under their jurisdiction. They eliminate duplicate requests, reconcile differences between requests for similar work from the shifts, return requests for work that is not economically justified to the originators with explanation why request will not be approved, and set realistic completion dates for work requested.

The operations coordinators originate request forms to the Engineering section requiring estimates and/or capital work management approvals.

The Maintenance Planner (former mechanic and maintenance supervisor) is the focal point of interdepartment contracts.

The operations coordinators and the maintenance planner jointly plan

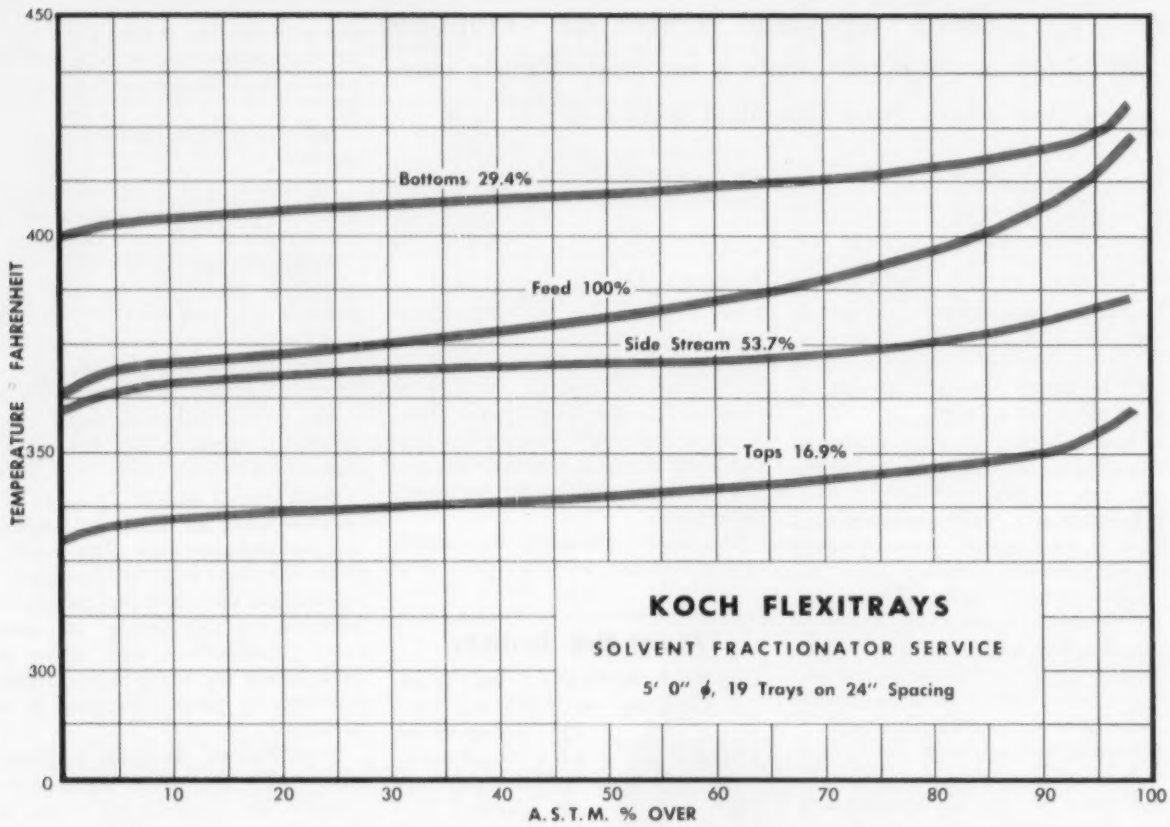
## Meet the Author

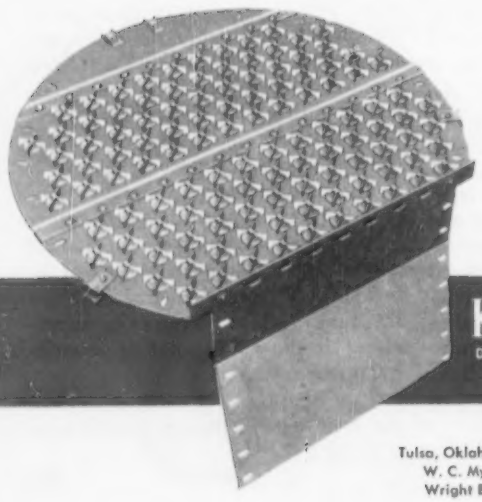
HARRY E. KINSELLA, with Union Oil Company of California since 1941, is engineering and maintenance superintendent for the affiliated Brea Chemicals, Inc., at Brea, Calif. Kinsella started with the parent company as an engineer and later served as a supervisor in the Maintenance and Operations department at Union Oil's Oleum refinery. Before taking his present post at Brea, Kinsella served Union Oil as an engineer in its home office and in the Process, Engineering and Construction departments. He later was named assistant superintendent of the Maintenance department at Oleum, and in early 1954 was appointed to his present position at Brea. He holds B.A., B.S. and Ch.Eng. degrees from Columbia University.

# Repeat orders PROVE

# Top Performers Prefer Koch Flexitrays

## FOR SOLVENT FRACTIONATION



The above graph illustrates the clean separation of relatively short boiling range solvents. The required flexibility and high tray efficiency for such separations has always presented a challenge to tray designers.

Numerous repeat orders from large solvent producers indicate an eventual complete changeover from bell caps to Flexitrays for this exacting service.

Flexitray's adaptability to existing downcomers and supports makes such replacements highly economical. The performance records of the Koch Flexitray are outstanding. Wire, write, or phone us on its application to your problem.

**KOCH ENGINEERING COMPANY, INC.**

DESIGNERS AND FABRICATORS OF MODERN TRAYS

321 WEST DOUGLAS — WICHITA 2, KANSAS

REPRESENTATIVES

Tulsa, Oklahoma, Repr.
W. C. Myers Co.
Wright Building

Houston, Texas, Repr.
Alpha Engineering Co.
P. O. Box 12371

Eastern, Repr.
Crawford Engineering Co.
295 Madison
New York, New York

Pittsburgh, Pa., Repr.
D. D. Foster Company
501 Alcoa Building

West Coast, Repr.
Jacobs Engineering Co.
3018 East Foothill Blvd.
Pasadena 8, California

sequences requiring synchronized Operation-Maintenance procedures and with the aid of the safety supervisor plan safety into every maintenance repair job.

The maintenance planner and his staff estimate job sequences, crafts and man-hours for all work requests and prepare bills of material for all work requests with the exception of those referred to the Engineering section.

The maintenance planner strives to schedule work requests in such a manner that the desired completion dates are met. However, if this objective cannot be achieved, the planner collaborates with the operations coordinator to adjust job priorities or contract manpower as necessary to synchronize maintenance repairs with the Operation plan.

Urgent work requests are phoned into the planning office directly from the operating units. Unless an emergency exists the planner advises the operations coordinators of these urgent work requests and again they collaborate in the determination of the scheduled jobs to be dropped.

Methods and procedures are streamlined as necessary to assure completion of maintenance work as rapidly and safely as possible. A good preventive maintenance program, detailed joint planning and good interdepartmental communications including briefing sessions before multi-sequence jobs result in less off-stream time for maintenance repairs.

**Periodic Review of Interdepartmental Relations.** There are bound to be differences of opinions, clashes of personalities and strained relations in any operation involving human beings. The Operation and Engineering & Maintenance departments have trained their personnel to settle differences at the proper level on a man-to-man basis. However, should this fail the next organization level is brought in to resolve the problem. Good departmental communication and periodic reviews of interdepartmental relations by the top supervisory personnel prevent minor personnel problems from becoming serious enough to open a breach in Operations-Maintenance relations.

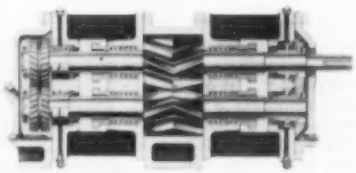
##


**Sier-Bath GEAREX® PUMPS**

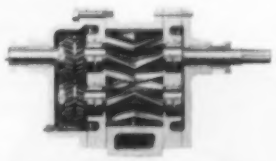
**Pumping lube oils for more than 5 years with minimum downtime at SOCONY MOBIL OIL CO., INC.**

*24 Sier-Bath "Gearex" Pumps,* internal gear and bearing type, are used in lube oil blending service at Socony Mobil's Greenpoint, Brooklyn Refinery. Each size C-3 "Gearex" Pump delivers 150 gpm. at 95 psi., with a viscosity of 2000 SSU and is driven by a 15 hp., 1750 rpm. motor. Pumps have built-in relief valves.

**Sier-Bath "Gearex" Pumps**



EXTERNAL GEAR & BEARING TYPE
for non-lubricating liquids



INTERNAL GEAR & BEARING TYPE
for lubricating liquids

Sier-Bath "Gearex" Pumps provide positive displacement, pulseless flow . . . quiet, vibrationless operation. Direct-connected up to 1800 RPM, they require no reduction gears. For sustained high volumetric efficiency and long life there is no rotor-to-rotor or rotor-to-casing contact. Low pressure on stuffing boxes provides easy servicing.

Horizontal or vertical models to handle 32 to 500,000 SSU, 1 to 550 GPM at 250 PSI for viscous liquids, 50 PSI for water. Corrosion-resistant alloys, steam-jacketed bodies, water-cooled bearings, other adaptations to meet individual needs. Call your local Sier-Bath Pump Representative . . . send for Bulletin G-2. *Sier-Bath Gear & Pump Co., Inc., 9261 Hudson Blvd., North Bergen, N. J.*

**Sier-Bath ROTARY PUMPS**

Screw Pumps — Gearex® Pumps — Hydrex® Pumps

50th Anniversary — Mfrs. of Precision Gears, Rotary Pumps, Flexible Gear Couplings — Member A.G.M.A.

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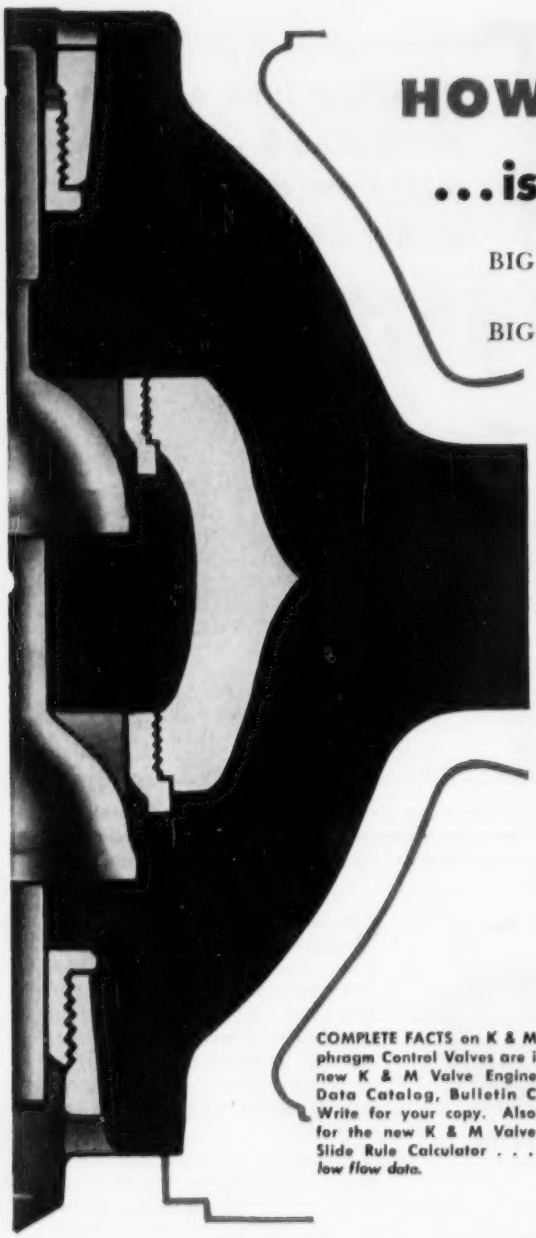


# HOW BIG

## ...is a K & M six-inch valve?

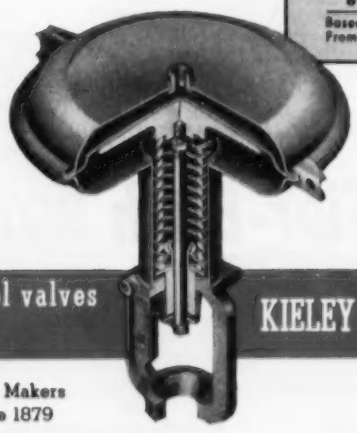
BIG enough to pass 500 gpm of cold water through the valve body at a constant drop of one pound pressure. BIG enough to provide the largest flow coefficient available in a standard six-inch diaphragm control valve. Body flow passages of all K & M valves, for example, actually average 140% of cross-sectional pipe area. There's more space for fluid to flow . . . smoothly, freely and without turbulence. Frequently a smaller nominal size K & M Valve provides sufficient capacity to satisfy requirements that formerly called for a larger, more expensive valve. Inner valve open areas, on the other hand, average only 80% of cross-sectional pipe area. Therefore, flow restrictions occur principally across the inner valve . . . where the restriction is controllable throughout the entire range of valve stem travel. This K & M design often permits lower initial costs . . . always contributes to more precise flow regulation through the K & M Inner Valve.

**COMPLETE FACTS** on K & M Diaphragm Control Valves are in the new K & M Valve Engineering Data Catalog, Bulletin CV53. Write for your copy. Also, ask for the new K & M Valve Size Slide Rule Calculator . . . with *low flow data.*

**$C_V$ COMPARISON TABLE**

| Valve Size | K & M | Valve B | Valve C |
|---|---|---|---|
| ¾" | 10.9 | 8.4 | 8 |
| 1" | 17.3 | 14.9 | 12 |
| 1½" | 39.1 | 33.2 | 28 |
| 2" | 61 | 57 | 48 |
| 2½" | 97.7 | 71.0 | 72 |
| 3" | 150 | 116 | 100 |
| 4" | 219 | 197 | 165 |
| 6" | 500 | 364 | 360 |

Based on the maximum $C_V$ at rated travel through the valve body. From manufacturers most recent slide rules or tables.



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K&M

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FIGURE 3—Aerial view of British Petroleum Company's Aden refinery on the Red Sea.

## British Petroleum

Continued from Page 101

meet all the local demand, let alone elsewhere in France. Accordingly, plans were drawn up for increasing the crude capacity of the refinery. The vacuum unit was converted to normal atmospheric distillation, and modifications were made to the existing topping unit. In this way, Lavera's throughput in 1947 was increased to nearly 20,000 bpd.

Lavera's present capacity is 50,000 bpd, a very considerable achievement when one considers that no additional distillation plant has been built. The increase is due solely to conversion of old units and removing bottle necks in all units by modifications to heat exchangers, pumps, etc.

In December, 1954, a Platforming unit was commissioned at Lavera, the first such unit in France.

BP decided shortly after the war to build a refinery in the north of France to supply the industrial areas in that region. Various sites were examined, and the company eventually decided to rebuild Dunkirk refinery from a plant transferred from its nearby refinery at Courchelettes, which had been severely damaged.

The refinery officially was opened in October, 1951, with a design capacity of 35,000 bpd. The actual capacity of the crude oil distillation units has since been increased to 45,000 barrels. Other plants include a thermal reforming unit and lubricating oil plant consisting of Texaco and JUIK solvent processes. Products include gasoline, gas oil, a varied range of fuel oils, lubricating oils, kerosine, liquid gases, solvents and white spirits, waxes, bitumens and asphalts.

In 1948, BP purchased a 49 percent share in Porto Marghera refinery, Venice, from the operating company, Azienda Generale Italiana Petroli. This refinery had been largely destroyed during the war. BP and AGIP established a joint operating company, Industria Raffinazione Olii Minerali, and planned not only to rebuild the refinery but to increase its capacity from 7500 to 25,000 bpd.

In December, 1951, a combination atmospheric and vacuum unit with a design capacity of 12,000 bpd was commissioned. The following year a thermal reformer came into operation, and a year later, in August, 1953, a catalytic polymerization unit. A lubricating oil plant was also commissioned in 1953.

To accommodate the new units, additional land adjoining the refinery was purchased, bringing the total refinery area to 136 acres.

The refinery has now exceeded its original capacity target, and is operating at 35,000 bpd.

Another refinery purchased by BP in 1948 was the Eurotank Refinery at Hamburg, on the south bank of the River Elbe. This again had been severely damaged during the war, and had not been operating at all during the immediate postwar years. A program of rehabilitation was started, and early in 1949 the first unit was brought on stream with a throughput of 3500 bpd. By the addition of some


This OPENING and CLOSING motion....

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your plug valves
AUTOMATICALLY
when you equip with....
DELTA
AUTOMATIC
PLUG VALVE
LUBRICATOR

Engineers agree that plug valves should be lubricated each time they are opened and closed.

NOW they can be—automatically—by the adaption of this simple, fool-proof device, that never forgets.

Each time the valve is opened and closed a measured amount of lubricant is forced in. The reservoir holds enough lubricant for the valve to be opened 50 to 80 times, and is refilled in seconds with the Delta Gun.

The savings in time, trouble and valves will repay the small cost of this Delta Lubricator again and again. Write for details and prices.

*The Only Complete Plug Valve Lubrication Company*

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PLUG VALVE
LUBRICANTS
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LUBRICANTS FITTINGS GUNS LUBRICATORS




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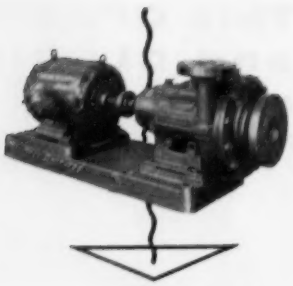

# *How to make a molehill out of a spare parts mountain*

Spare parts for plant machinery are a necessary evil. Nobody loves them—but no plant can afford to be without them. And when it comes to *pumps*, your stock of repair parts can be pretty mountainous—and mighty costly.

But not with Dean Brothers standard centrifugal pumps! Here's why: a single basic cradle assembly serves for an entire series of pumps covering a wide range of applications. Only the Casing, Impeller and Suction Nozzle vary in size with the capacity of each individual pump. All other parts are the same. Obviously, such interchangeability cuts spare parts to an almost unbelievable minimum.

Think what this interchangeability means to you—particularly with a multiple pump installation. Your spare parts mountain becomes a molehill. Fewer parts mean less investment . . . require less storage space . . . take less time to handle and keep inventory records.

This interchangeability is but one of many features which make Dean Brothers standard centrifugal pumps* the best in the long run. For full information, send for Circular No. 184A.

*Series 10, Series 20 and Series 30—to 7,000 gallons per minute capacity.

*HERE'S HOW IT WORKS*

The eleven pumps in Series C-10 will pump anywhere from 10 gallons per minute up to 700. Total dynamic head can be as little as 25 ft. or as much as 400 ft. Pumping temperatures can be as low as 250° F. below zero or as high as 350° above. Think of it! Eleven pumps covering a range of conditions like this assembled from the same parts with variations in only three parts—all without sacrificing mechanical reliability. But that's only half of it. There's a companion series for high temperature services—Series R-10. The only difference between the two series is that the cradle housing in Series R-10 is integrally water jacketed. All other parts are the same. One shaft fits all 22 pumps. Likewise one shaft sleeve and one set of packing. The bearings are the same—and so on throughout both series.

**DEAN BROTHERS PUMPS INC.**

INDIANAPOLIS 7, INDIANA

*Centrifugal and Reciprocating Pumps · Since 1869*

## As Management Sees It . . .

heat exchange equipment and minor alterations to the furnace, this throughput was nearly doubled six months later.

By August, 1950, the Winkler-Koch combined topping, reforming and cracking plant that had been installed just before the war was rebuilt and commissioned. With the commissioning in 1954 of a newly built combined atmospheric and vacuum distillation unit, the refinery reached its present capacity of 33,000 bpd. Later the same year a 6000-bpd Platforming unit was brought on stream.

In 1950 the company operating the Hamburg refinery was merged with "Olex," the then marketing subsidiary of BP in Germany. The name has since been changed to BP Benzin-und Petroleum, GMBH, and as such controls both the refinery and distribution.

In March, 1951, British Petroleum extended its interests in Germany by acquiring a majority holding in Oelwerke Julius Schindler, which owns a refinery near Hamburg and a lubricating oil blending and grease manufacturing plant at Peine, near Hanover. The Hamburg plant now has a capacity of about 5600 bpd, producing gasoline, kerosine, gas oil, fuel oil, and a wide range of lubricating oils and specialities.

BP's expansion on the Continent has not only been confined to enlarging existing refineries. Soon after the war, it became apparent that a refinery was needed in northwest Europe to supply markets in Belgium, Holland, Luxembourg, Switzerland and the Rhineland.

In the Spring of 1948, BP and Petrofina launched a joint project to construct a refinery at Antwerp with a capacity of 30,000 bpd. An operating company, Societe Industrielle Belge des Petroles, was formed. The site chosen was some five miles from Antwerp, at a point where the dock system joined the river.

Preliminary work on the refinery began towards the end of 1949, and production started two years later. The refinery is now operating at 65,000 bpd.

The main refinery units are: a distillation unit, a reformer, a combination viscosity breaker and thermal cracking plant which has now been converted for distillation, a catalytic



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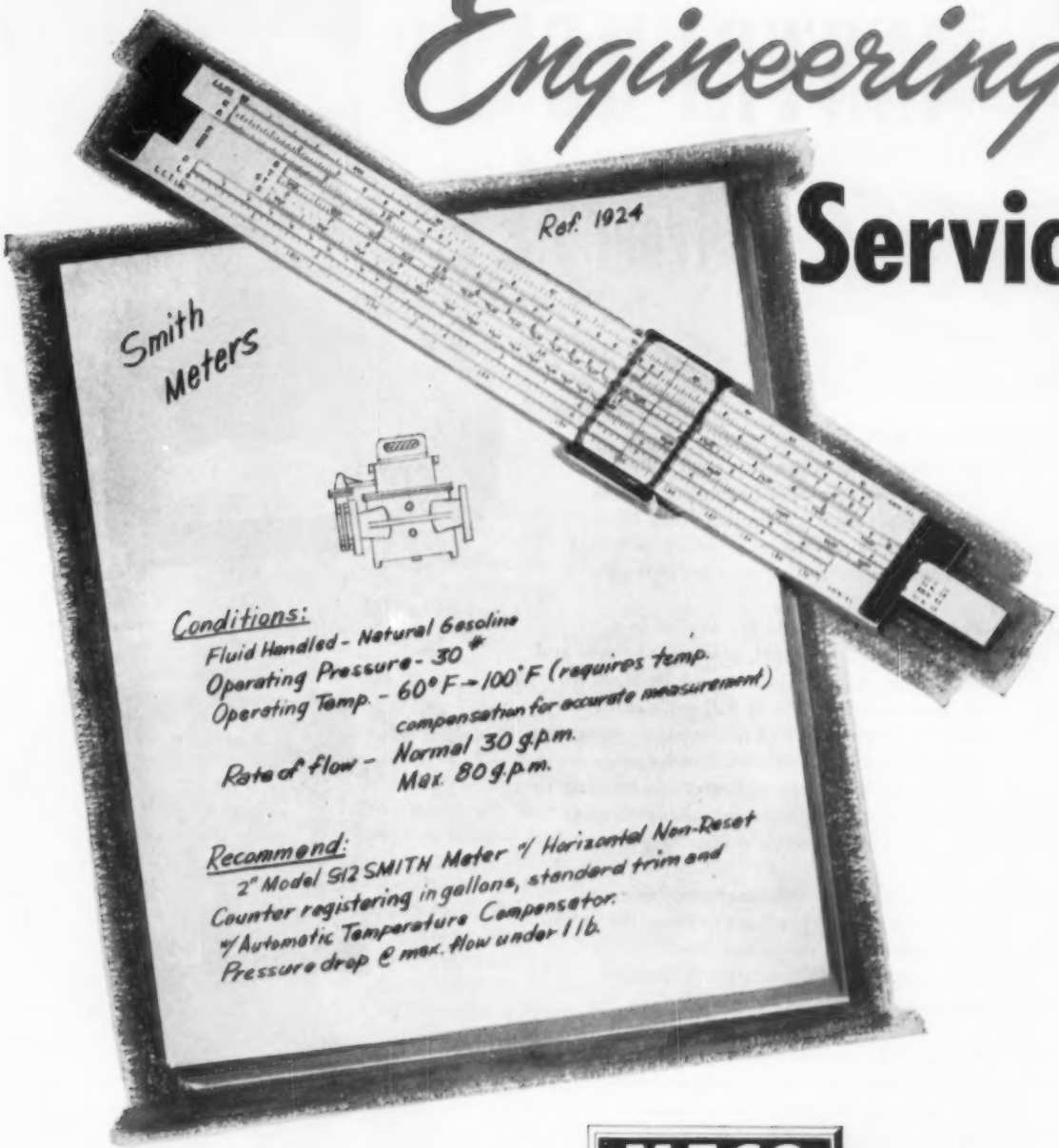
# Equipment with *Engineering* Service


Ref. 1924
Smith
Meters
Conditions:
Fluid Handled - Natural Gasoline
Operating Pressure - 30 #
Operating Temp. - 60° F → 100° F (requires temp.
compensation for accurate measurement)
Rate of flow - Normal 30 g.p.m.
Max. 80 g.p.m.
Recommend:
2" Model S12 SMITH Meter w/ Horizontal Non-Reset
Counter registering in gallons, standard trim and
w/ Automatic Temperature Compensator.
Pressure drop @ max. flow under 1 lb.

MECO

**MAINTENANCE** *Engineering* **CORPORATION**

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3711 CLINTON DRIVE
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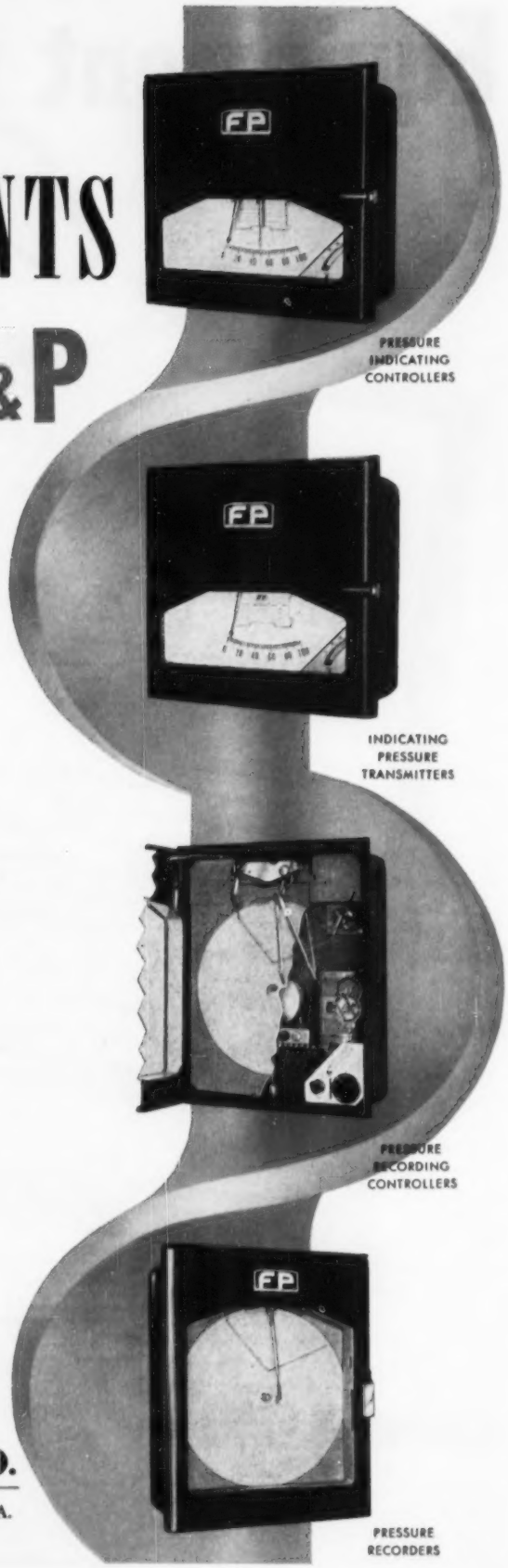
# get PRESSURE INSTRUMENTS FAST from F&P




Fischer & Porter now proudly offers a complete line of pressure instruments for one week shipment from stock. These accurate pressure instruments may be used to measure vacuum pressure or gauge pressure from absolute zero to 1,000 psig.

The pressure elements are available in brass, 316 stainless steel, phosphor bronze and berryllium copper. Guaranteed accuracy of all instruments is 1% of full scale, with positive over-range and under-range protection built into each instrument. Recorders, recording controllers, indicators, indicating controllers and pneumatic transmitters are available for one week shipment.

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Fischer & Porter is in the instrument business to assist you. Doing it expertly and well has helped F&P grow. Get to know F&P better, call on F&P for a single instrument or a complete process instrumentation system.

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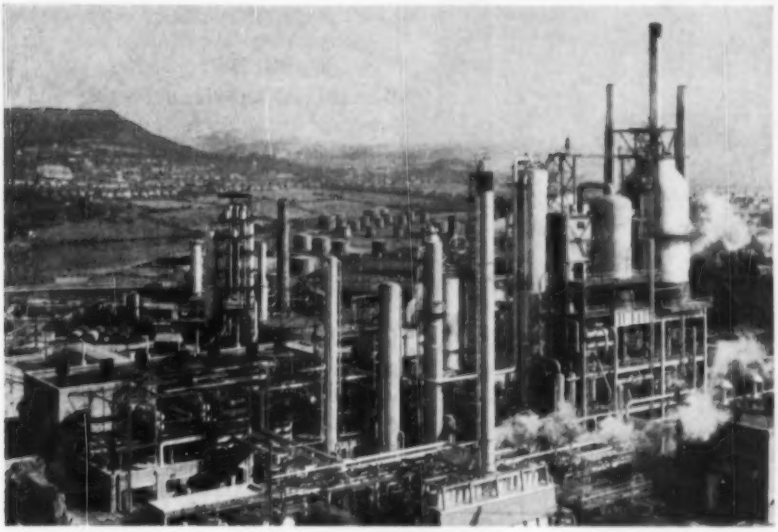

FIGURE 4—Llandarcy refinery, South Wales. Cat cracker is shown in foreground, with Welsh Hills rising in background.

cracking plant and catalytic polymerization plant.

**Aden**—British Petroleum's biggest single construction project overseas since the war has been the building of a 120,000-bpd refinery on the peninsula of Little Aden, six miles across the bay from the Red Sea port of Aden.

Work started in November, 1952, and the first unit came on stream 21 months later in August 1954—four months ahead of schedule. The refinery cost $126 million.

The refinery has five main units: two distillation units, $SO_2$ plant, an Autofiner, and a Platformer. The distillation units have the distinction of being the first in the world to be electronically controlled.

The Autofining process, which removes sulfur from a wide range of products, was invented and developed by BP. The Aden plant is used to desulfurize power kerosine at the rate of 3200 bpd.

Two 19-mile pipe lines, one 16 inches and the other 6 inches in diameter, have been laid from the refinery to the BP bunkering installation at Aden. Over 41,000 bpd of various grades of oil are pumped to the installation for ships' bunkers.

The oil port built adjacent to the refinery consists of a finger jetty, alongside which two tankers can berth, and two T-head jetties, each providing a berth for one tanker. Dredgers lifted about 6 million cubic yards of sand from the approach channel and turning circle. The sand was pumped ashore to reclaim an area of 200 acres on which tanks and port offices have been erected.

**Kwinana**—About the same time as BP was considering the construction of a refinery in the Middle East, the company also decided to build a refinery somewhere in Australia to meet the expanding market for oil products in Australasia.

A site was chosen at Kwinana, on the shores of Cockburn Sound, 17 miles south of Fremantle.

In November, 1952, the first subcontracts were let for such jobs as preliminary scrub-clearing and fencing, four miles of which were needed to enclose the 950 acre site. The 70,000-bpd refinery started up on February 1, 1955, when the first distillation unit was commissioned—more than three months before the scheduled time. On October 25, the refinery was opened officially.

The total cost of the refinery was about $84 million.

The main refinery units include two atmospheric distillation units, a vacuum distillation unit, a catalytic cracker, a Platformer, a Hydrofiner, and copper chloride sweetening units. Two units require special mention. The catcracker is of the "orthoflow" design, whereby both reactor and re-

SERV-RITE

Insulated Thermocouple Wire Extension Lead Wire

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PLATINUM COUPLES
CHROMEL ALUMEL
IRON CONSTANTAN
COPPER CONSTANTAN
IRON CUPRONEL

No matter what your wire or insulation requirements may be, you can depend on Gordon "Serv-Rite" insulated wire for pyrometers—recognized as a standard of highest quality for nearly half a century. All "Serv-Rite" wire is now manufactured in the new, completely modern Gordon plant, employing up-to-date equipment and machinery, supervised and operated by skilled technicians—your guarantee of continued precision quality. In addition to maintaining large stocks of all common types of wire, Gordon will manufacture special insulation, in long or short runs, to suit your individual needs and meet your most rigid specifications.

All Types of Insulation

Felted Asbestos
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Stainless Steel Armored Braid
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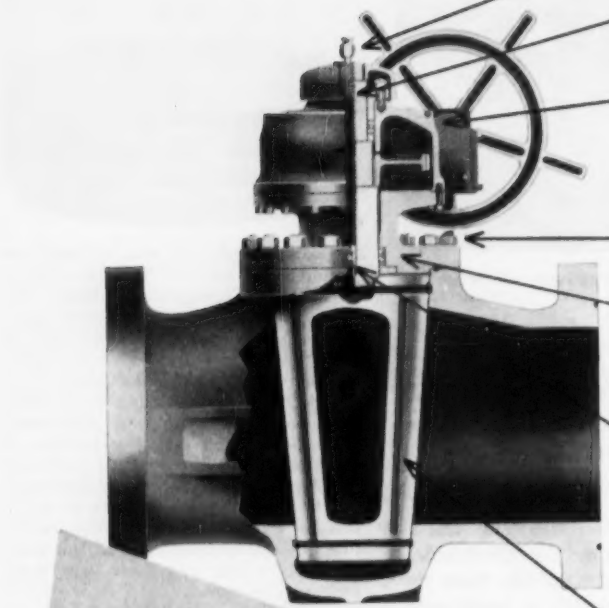
# LET'S EXAMINE WALWORTH LUBRICATED PLUG VALVES



Button-head lubricant fitting and lubricant screw. Screw is not removed when using a Walworth High Pressure Lubricant Gun.

Lubricant-Fitting screw has "Telltale" safety groove.

For buried pipelines this yoke design permits simple attachment of handwheel and lubrication extensions without modifying the gearcase.

Standard bolt threads, rather than special threads, permit easy replacement from local stocks.

Two overlapping Teflon packing rings form an effective seal against leakage without "grabbing" the plug shank. Packing serves only as a seal and is not used to hold the plug in its seat.

In the stainless steel check valve unit, a transverse pin holds two balls in their seats. There is no chance for line pressure to get into the lubricant system when the valve is properly adjusted and lubricated.

Lubricant grooves completely frame the port openings and encircle the plug at the top and bottom, assuring a tight seal against leaks. Bottom circumferential groove is separate from, but connected with, the lubricant well.

## ADVANTAGES OF PLUG VALVES

1. Quick Opening.
2. Positive seal on Light Hydrocarbons.
3. Less space than Gate Valves.
4. Available in Three-Way and Four-Way.
5. Can be used with Locking Device.

J&L STEEL

Jones & Laughlin
STEEL CORPORATION
SUPPLY DIVISION – Tulsa
SERVING THE UNITED STATES AND CANADA

125-G



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generator are housed in the same column, thus giving economy of construction and operation. This is the first catcracker of such design to be installed in one of BP's refineries.

Another unit making its first appearance is the Hydrofiner. This Hydrofining process has been developed to meet BP's particular requirements.

**Current Development**—Although BP's main refinery expansion schemes have been finished, individual new units are constantly being installed.

At Kent Oil Refinery in the U. K., a new aviation gasoline plant is to be built. With a production of some 3500 bpd of aviation spirit, this is expected to be in operation in 1958. It will cost about $18 million.

Also at Kent, a plant is to be installed for the production from oil of town gas for domestic use. It will be the first such plant in the country.

Hydrofining units, similar to that in operation at Kwinana, are to be built at Kent refinery and at Hamburg refinery in Germany. The Hamburg unit will have a capacity of about 6000 bpd and the Kent unit, 10,000 barrels.

To meet the increasing demand in Australia for "bottled gas," a liquid petroleum gas bottling plant is to be built at Kwinana refinery. Butane and propane gases will be taken from the distillation units.

A 2000-bpd Platformer is being erected at Venice refinery. It will be the first Platformer in Italy.

One of the company's biggest single expansion schemes at present in progress is in the field of petroleum chemicals. Over $22.5 million is to be spent on building new units at the British Petroleum Chemicals plant adjoining Grangemouth refinery, Scotland. One of the projected new units, treating a stream from two gas separation plants, will extract butadiene.

Another innovation will be the production by catalytic means of a polymer of propylene. Some of this polymer will be the feedstock to yet another unit being erected for Grange Chemicals Ltd. (in which British Petroleum Chemicals and the Oronite Chemical Company are partners). Here dodecyl benzene will be produced for sale to detergent manufacturers.

The new units are scheduled to be commissioned between early 1956 and the first half of 1957. ##

OIL MEN Specify:

2200-5000 Volts

EC&M

50,000 KVA
Interrupting Capacity
MOTOR STARTERS

Diesel-Loading pumps with EC&M Div. 2 Starters.

Petroleum engineers specify these Starters for Division 2 semi-hazardous locations because they assure substantial savings in installation and operation.

Construction advantages include: Type III weather-resisting enclosure with drip-proof roof, tank-cover and front-cubicle doors . . . oil switch which opens 220-volt control transformer before upper door can be opened to operate main line disconnects . . . overload and control relays in flanged (Class I, Group D) enclosure with removable cover . . . main contactor with alloy contacts oil-immersed in rear tank. On voltage dips, push button circuit maintained up to 2 seconds by simple 3-wire circuit. "Stop circuit" opens without delay when "Off button" is pressed.

EC&M 2200-5000 volt Starters are also available in Totally Oil-immersed Division 2 Style and in Division I style. Both are available with Oil Disconnect Switch (for main line).

OUTSTANDING ADVANTAGES

1. Reduced floor space
2. Low-cost Div. 2 design
3. 50,000 KVA interrupting capacity
4. Combination starter with Disconnect Switches
5. Corrosion resistant, weather-proof construction
6. Copper tungsten contacts for positive operation
7. Simple 3-wire TIME-DELAY UVP push button circuit
8. THERMAL-MAGNETIC Overload Relays give accurate motor protection . . . trip instantly on faults
9. All internal wiring complete
10. Self-contained bus and pot-heads are optional

6723

*Write for 16-page Booklet 1062 for complete details.*

THE ELECTRIC CONTROLLER & MFG. COMPANY

4498 LEE ROAD • CLEVELAND 28, OHIO




For more data on advertised products, use Readers' Service Cards, last page.

*Liquid Assets*

## CARRIED BY MODERN TANK CAR SERVICE!

Whatever your "liquid assets" are, you can look to Shippers' Car Line for prompt, low-cost transportation. The reasons are simple: The world's most *modern* equipment—the revolutionary DURADOME tank car is leased and sold exclusively through Shippers'. A network of *modern* repair shops—strategically located to keep your cars in top shape. 35 years of *specialized* experience in the operation and maintenance of tank car fleets for industry.

*Whether you prefer to buy or lease, you'll benefit from a talk with your Shippers' representative . . .*

SHIPPERS SHPX CAR LINE

SHIPPERS' CAR LINE CORPORATION
A subsidiary of ACF INDUSTRIES, Incorporated
30 Church Street, New York 7, N. Y.

CHICAGO, ILL. • HOUSTON, TEX. • SAN FRANCISCO, CAL. • MILTON, PA. • EAST ST. LOUIS, ILL. • SMACKOVER, ARK. • TULSA, OKLA. • NORTH KANSAS CITY, MO.

As Management Sees It . . .

# Automation—What It Means

## It will have an impact on our future.

**M. L. Powers**
University of Oklahoma, Norman

AMERICANS enjoy the highest standard of living in the world. We maintain these standards by working only 40 hours a week.

*Why?*

Because we have learned to make more effective use of time and effort with the help of automatic machines.

Automation is not new. In fact, all that is new is the word. Automation is the continuation of an evolution that has been going on since the beginning of civilization. Man, being somewhat lazy, is constantly trying to find better and easier ways to provide material goods for his family. That better way requires a continual improvement in the use of tools and equipment.

As automation continues to improve, what will the future bring?

**Displaced Jobs.** Increased use of automatic machines will replace workers, it's true. However, we have been replacing people with labor-saving machinery since the industrial revolution began over 50 years ago. Take the loom, for example. One loom weaves much more cloth than a man, so naturally thousands of people have lost that particular type of job. In fact, machinery has thrown people out of work to the extent that we now have only 65 million on company payrolls —the largest employment figure ever recorded in the U. S.! How do we explain this?

The types of jobs displaced by ma-

### New Word For An Age-Old Idea

**You won't find the word "automation" in the dictionary. It is too new. The word was created a few years ago while a young graduate student, John Diebold, was writing a report on the use of self-regulating machines in factories and offices. He discarded the dictionary term "automatization" as too clumsy and made up his own word "automation." Diebold's verbal shortcut is now the accepted label for a new industrial era. Diebold, who has become a leading expert in the automation field, has this to say about the word's meaning: "When machines do a man's work, that's mechanization. When they do his work and control their own operations as well, that is automation."**

**Prolong the Life of Vessel Liners by Armoring them with . . .**

KLEMP HEXTEEL ▶

*Hexteel is an armor and retainer for castable refractory monolithic linings used for cat crackers, reactors, regenerators, fractionators, heaters, strippers, risers, stacks, cyclones, ducts, breeching, furnaces and tanks.*

and FLOORSTEEL ▶

*Floorsteel is an armor and retainer for monolithic liners applicable to small diameters for pipe linings, heads, plenum chambers, sumps, stacks and furnaces.*

Hexteel and Floorsteel carbon or stainless steel armors and retainers prolong the life of vessel liners by resisting abrasion and corrosion. Our engineering department is prepared to design your total lining requirements. Whatever the destination, we will deliver your Hexteel or Floorsteel world-wide in record time!

Emergency delivery of Klemp Hexteel via air transport

Write for your FREE copy of "Serving the Oil Industry for Over 40 Years."

KLEMP METAL GRATING CORP
6601 South Melvina Avenue
Chicago 38, Illinois

KLEMP METAL GRATING CORPORATION PR
6601 South Melvina Avenue, Chicago 38, Ill.
Gentlemen:
Kindly send me literature describing Hexteel and Floorsteel applications in the petroleum and chemical industries.
Name
Firm
Address
City Zone State
Phone



For more data on advertised products, use Readers' Service Cards, last page.

chinery usually fall into two groups:

• *The single skill or operative job.* It is a highly repetitive job and requires very little mental effort on the part of the operator. He really doesn't mind losing the job anyway. The interest factor is very low.

• *The very heavy job.* Wherever possible, a machine is devised that will pick up and handle heavy items or do heavy work, thus relieving thousands of men from back-breaking labor.

**New Jobs Created.** As the "drudgery" and "back-breaking" jobs disappear, automation will provide new job opportunities in the following fields of work:

1. More machines will be manufactured. Tool designers will be needed to create the machinery. Tool makers will be needed to manufacture the machinery. Machinists will be needed to construct the machinery.

2. More skilled workers will be needed to install machinery in the factory and in the home.

3. There will be an increased demand for trained maintenance personnel. As a typical example, there is a plant which employs 24 electricians. These men have been with the company for several years. New automatic electronic equipment has been installed and it now develops that only three of the men know how to adjust or repair the new machinery. There are no jobs for the remaining 21 men and there is no source for additional men to maintain the new equipment. The company solved the problem by upgrading all the men who had the aptitude to the point where they could service and maintain the equipment.

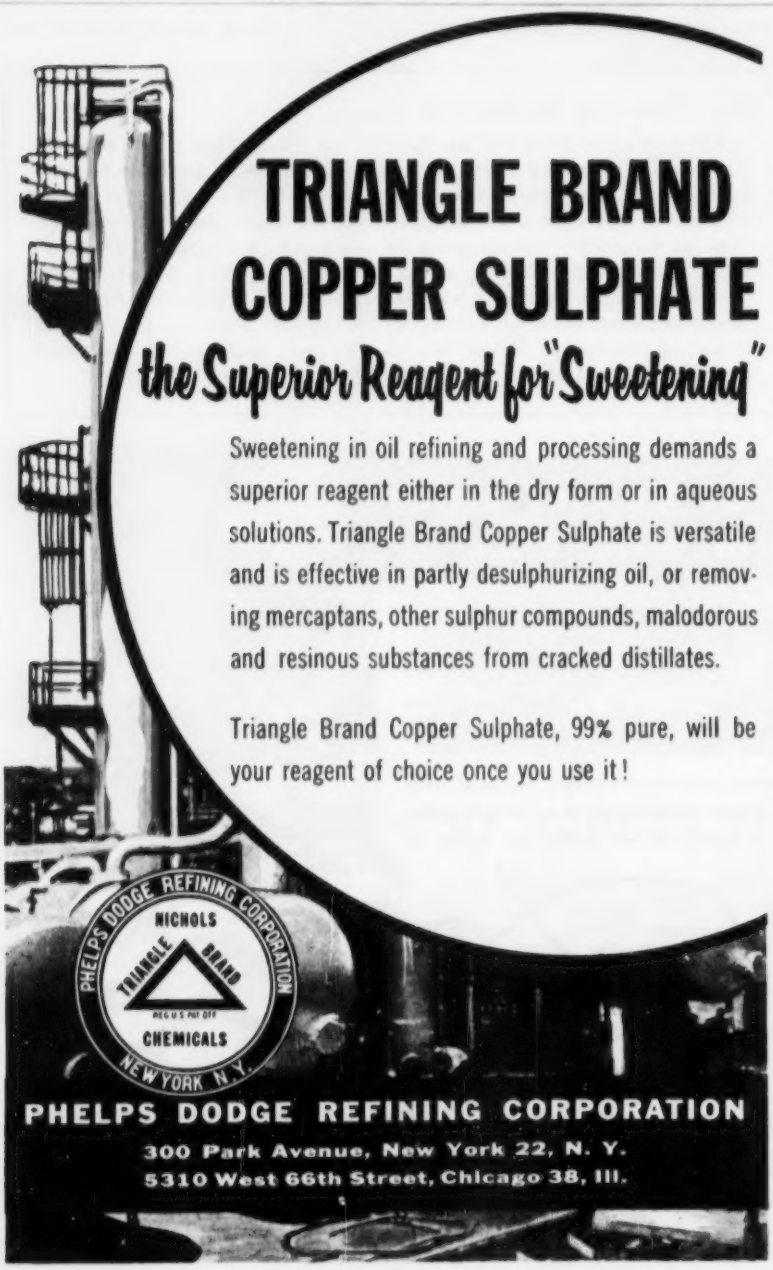
**New Roles for Management.** Along with automatic machinery will come new responsibilities for management. Work needing supervision is becoming more complicated making it necessary for management to keep abreast of new technical developments.

The men who report to management will be doing work of a more technical nature. The result will be fewer men to supervise—but those few will need closer supervision.

With the work becoming more technical, the supervisor will be required to spend considerably more time training men for their jobs. Each man's work will tend to become more of a specialty. The jobs will require a high degree of skill and the supervisor is the only logical source for the employee to seek this technical know how.

There will be a continuing need for the improvement of process and procedure to maintain competitive position. This requires not only increased effort and ability on the part of management, but also the support of each man on the job. There must also be close cooperation and coordination of activity with all staff departments, especially engineering, research and development. Other departments will also play a vital role in automation. Certainly, marketing will continue to be a very important department—and by all means accounting, for we must always know where we have been if we are to orient ourselves to the future—the promising future of automation.

This was excerpted from a speech by M. L. Powers, Director of Business and Industrial Service, University of Oklahoma, at Regional meeting, Natural Gasoline Association of America, September 29, 1955. ##


TRIANGLE BRAND
COPPER SULPHATE
the Superior Reagent for "Sweetening"
Sweetening in oil refining and processing demands a superior reagent either in the dry form or in aqueous solutions. Triangle Brand Copper Sulphate is versatile and is effective in partly desulphurizing oil, or removing mercaptans, other sulphur compounds, malodorous and resinous substances from cracked distillates.
Triangle Brand Copper Sulphate, 99% pure, will be your reagent of choice once you use it!
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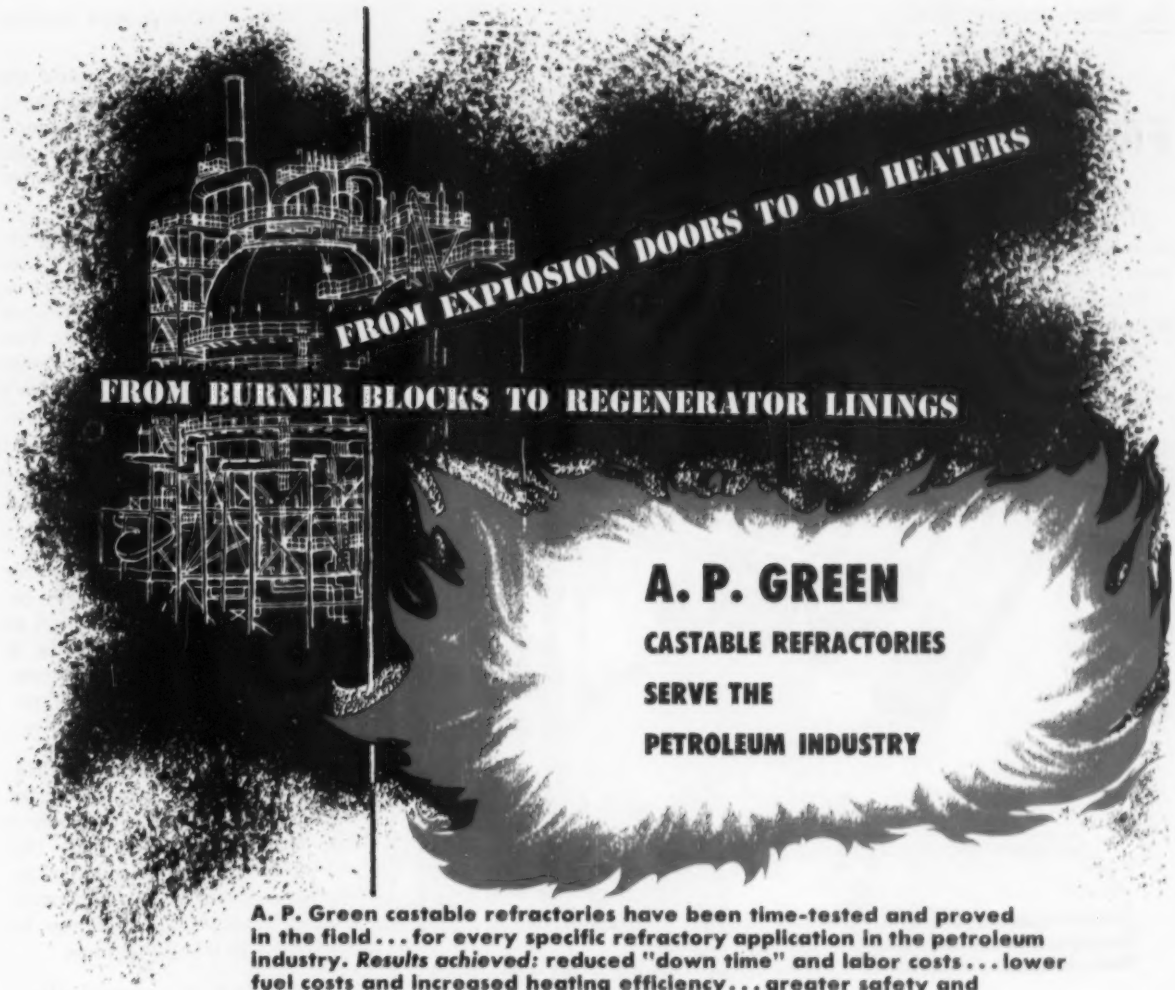


**A. P. Green castable refractories have been time-tested and proved in the field . . . for every specific refractory application in the petroleum industry. *Results achieved:* reduced "down time" and labor costs . . . lower fuel costs and increased heating efficiency . . . greater safety and reduced maintenance control.**

**For detailed information and specific recommendations . . . write, Engineering Department, A. P. Green Fire Brick Company . . . or call your local A. P. Green distributor.**

## A. P. Green Castable Refractories . . . designed to exact specifications to do an exact job

**KAST-SET** — A rapid setting, high strength refractory castable. Mixed with water, it takes on a hydraulic bond without the application of heat. KAST-SET will not shrink, has excellent resistance to abrasion, and is ideally suited for monolithic linings. It may be used at temperatures up to 2700° F.

**KAST-O-LITE** — A lightweight castable recommended for temperatures up to 2500° F. It is used for monolithic linings in all types of stills and heaters, tar stills, heat treating furnaces, flues, and stacks. Reduces heat loss. Insures closer temperature distribution and control.

**CASTABLE INSULATION NO. 20** — A hydraulic-setting castable for temperatures up to 2000° F. Recommended for complete monolithic linings and lightweight panel construction in oil stills and heaters. Weighs 50 pounds per cubic foot in place.

**CASTABLE BLOCK MIX** — A hydraulic-setting castable insulation for temperatures up to 1600° F. CASTABLE BLOCK MIX combines the advantages of a castable material with low conductivity and light weight. It provides maximum insulating efficiency and ease of installation. Weighs only 20 pounds per cubic foot in place.

**CASTABLES FOR GUN APPLICATION . . . SK-7** — Gun application of SK-7 produces a lightweight lining with excellent strength and insulating efficiency for temperatures up to 1800° F. Installation and labor costs are reduced . . . no forms required. Ideal lining for ducts, flues and breechings.

**KS-4** — This strong abrasion resistant castable can be gun applied with a minimum of rebound loss. Recommended for catalytic regenerator linings, stack linings, bubble towers, and duct linings exposed to abrasion or corrosion. For temperatures up to 2550° F.

A. P. Green REFRACTORY PRODUCTS

**A. P. GREEN FIRE BRICK COMPANY**
Mexico, Missouri, U.S.A.
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**DISTRIBUTORS IN THE PRINCIPAL CITIES OF THE WORLD**


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# Five Ways to Safety

IT HAS BEEN SAID over and over that we can be as safe as we want to be.

This time-worn statement still rings true—in part. We *can* be as safe as we want to be—IF someone provides leadership in pointing out the right ways to safety. This calls for a new safety idea—one that will change the present approach from a safety campaign into a *crusade against carelessness.*

An important goal is to make the public realize that organized safety work is not only to protect an individual against his own acts, but also to protect him against the acts of others.

The individual should be encouraged to behave safely for his own protection. But, he should also be compelled by public opinion to behave safely for the protection of others. The sooner we can induce the average refinery worker to become his brother's keeper on the job, the sooner we can swing away from thousands of accident-caused lost man hours.

This crusade against carelessness can be brought about in five ways:

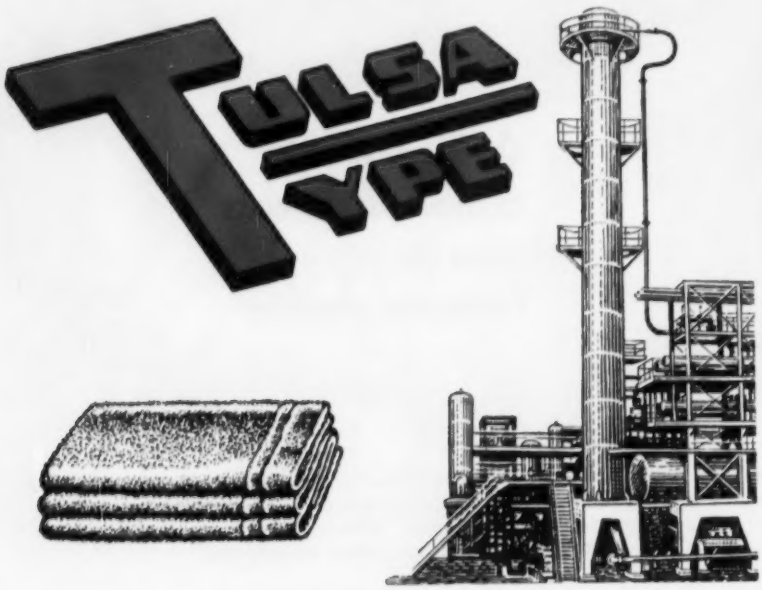
**1. Accept moral and social responsibility.** Emphasis on individual responsibility tends to make one feel as if he has done his part when he is personally careful to avoid accidents. We must, as moral citizens, be concerned about our fellow man.

**2. Be aggressively responsible.** Merely talking about what should be done to stop accidents is of some value, but not much. Putting the blame on others is of no value whatever. The aggressively responsible person will take positive action by urging effective safety programs.

**3. Realize factual responsibility.** The valuable lesson is, "You can't do business on rumors." There is always the danger that rumors, widely and persistently repeated, will grow into beliefs and consequently affect behavior. This can be particularly harmful when those rumors concern accidents or accident prevention.

**4. Be technically responsible.** Management must provide safe work conditions, suitable guards, and a well planned safety program. Public officials must be held responsible for high standards of traffic engineering and enforcement. Manufacturers must be held responsible for incorporating every practicable safety device in the design and construction of machinery. Educational agencies must be held responsible for correct attitudes and superior skills.

**5. BE YOUR BROTHER'S KEEPER—STOP ACCIDENTS!** ##


## TOWELS, TOWERS and TRADEMARKS

A well-known trademark — the signature of a product's maker — is as important on a giant steel bubble tower as it is on your best guest towels. And TULSA TYPE, for 30 years the trademark of FLINT STEEL refinery and natural gasoline plant equipment, has become one of the best known labels in the industry.

The TULSA TYPE name is your assurance of sound engineering and precision workmanship on every piece of equipment. All manufacturing processes used in the fabrication of TULSA TYPE equipment comply with API-ASME and ASME industry codes. Look for TULSA TYPE when you need steel plate fabrication for petroleum or petrochemical plants.

BUILT Right

*Write for our General Catalog*

**FLINT STEEL CORPORATION**
TULSA, OKLAHOMA

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# Costly liquid loss in process vessels with Schuylernit mist eliminators.

Schuylernit (wire mesh) mist eliminators for the chemical and petroleum industries are custom designed and constructed for positive, economical separation of liquid and small solid particles from any gas or vapor. **Recommended for: Vacuum and flash towers . . . gas absorbers . . . evaporators . . . distillation equipment . . . knock-out-drums . . . steam drums . . . scrubbers . . . gas filters and compressors.**

**Advantages: Increases throughput . . . improves process efficiency . . . eliminates liquid loss . . . reduces vessel sizes . . . reduces contamination . . . improves product quality.**

Immediate delivery on round, square or special shapes in any thickness for new or existing equipment. Send for illustrated bulletin 203, Schuyler Manufacturing Corp., 81 Porete Avenue, North Arlington, N. J.

*specialists in liquid/vapor separation*

SCHUYLER

**MANUFACTURING CORP., NO. ARLINGTON, N. J.**



For more data on advertised products, use Readers' Service Cards, last page.

# What's Happening . . .

## . . . in the Industry

### Pipe-Line Firm to Buy Its Second Refinery

El Paso Natural Gas Company, which recently acquired McNutt Oil & Refining Company, now is negotiating for the purchase of other New Mexico refining facilities. The big pipe-line and producing company would like to buy the Malco Refineries, Inc., plant at Prewitt, N. M. The refinery has a daily capacity of 2500 barrels.

The McNutt acquisition, El Paso's first venture into petroleum refining, included a refinery at Brickland, N. M. It is rated for 3200 barrels a day. El Paso is expected to install additional facilities to permit blending and direct processing of gas liquids.

The purchases are being made in an effort to find the best markets for El Paso's 25,000-barrel-a-day production of natural gasoline and LPG products. The company also is planning to enter the petrochemical field. (**See Who's Building.**)

The Prewitt refinery is equipped with a thermal-cracking unit and a catalytic reformer, with 1000-barrel-a-day capacities, and a 65-barrel-a-day catalytic-polymerization unit.

Malco recently purchased Wilshire Oil Company, operator of a 22,000-barrel-a-day refinery at Norwalk, Calif. If the Prewitt refinery is sold to El Paso, Malco will expand its 10,000-barrel-a-day facilities at Artesia.

### Fluid Coke to be Used In Generating Electricity

Fluid coke, from the new coking unit at Esso Standard Oil Company's Baltimore refinery, will be used for the first time commercially as a fuel to generate electricity. The new petroleum-derived material will be used by Public Service Electric & Gas Company in Newark, N. J.

The utility company has agreed to take the unit's total output. The fluid-coking unit, which went on stream in September 1955, will produce about 150 tons of coke a day.

The fluid-coking process was developed to make gasoline and heating oil from residue. It has helped the Baltimore refinery get 10 percent more gasoline from crude, bring the total gasoline yield there to 50 percent or more.

The first such unit, developed by Esso Research & Engineering Company, was put on stream by The Carter Oil Company at Billings, Mont. Esso Research also has licensed fluid coking to four other companies.

## LP-Gas Sales Hit All-Time High; Another Record Year Predicted

LP-Gas sales shattered all records in '55. Outlook for '56: Another record year.

The 1955 sales increase of 880,467,000 gallons was the largest in the industry's 33-year history. This represents a 17.2 percent gain over 1954—a remarkable record when one considers that the industry has been characterized by phenemonal growth. Total sales soared to 6,006,000,000 gallons!

Here is the break down:

**Domestic and Motor Fuel,** up 15.3 percent to 3,661,000 gallons. Increase of 487 million gallons exceeded all industry sales in 1941.

**Industrial and Miscellaneous** (LP-Gas for flame cutting, uranium refinery operations, etc.), increased 7.3 percent to 431 million gallons. LP-Gas proved its versatility by advancing in spite of continued natural gas extensions.

**Gas Manufacturing,** decreased by 10.9 percent to a total of 171 million gallons to continue trend started in 1951. However, there is an important industry development in the increased cooperation between gas utility companies and the LP-Gas industry. More joint gas promotion was seen in 1955 than any year in history.

**Chemical Manufacturing** use of LP-Gas even outstripped the upswing in the chemical industry by advancing 20.2 percent for a total of 1,262,000 gallons. This trend should continue into 1956 as large ethylene and polyethylene plants now under construction are placed in operation.

**Synthetic Rubber,** use of LP-Gas for manufacture of synthetic rubber components had biggest single increase—65.3 percent for a total of 481 million gallons. It is believed present high rubber demand will continue during the coming year.

A trend is developing in the refining industry toward increased use of butylenes in the production of high octane motor fuel. For numerous refiners, this is the cheapest, and for some the only means of meeting the higher octane requirements of today's automobile engines. A butylene shortage has already developed and will become more critical as octane numbers are pushed higher and higher. Thus, butadiene manufacture will depend more and more on normal butane as its raw material.

**Supply.** The production capacity of the LP-Gas industry continues to increase. Twenty-two new plants came on stream in 1955 with a total production capacity of nearly 850 thousand gallons per day. It is estimated 12 new plants will be added in 1956 with a production capacity approaching a half million gallons per day.

**Storage.** Large increases were seen in 1955 in LP-Gas storage facilities in both the conventional aboveground steel storage tanks and in underground storage facilities. It is estimated that the LP-Gas underground capacity is now 602,700,000 gallons. An additional 292 million gallons of underground storage is either under construction or proposed.

There was more interest shown in refrigerated storage of LP-Gas in 1955 but none definitely announced. Such storage would be in insulated vertical tanks at low temperatures and pressures.

**Export and Foreign.** LP-Gas export sales are up about 10 percent. LPG distribution is making rapid strides in Canada, Venezuela, England, France, Italy, Mexico and in the Scandinavian countries. There is at least one LPG tanker operating out of Italy, three out of Scandinavian countries, and at least four more LPG tankers are in service at other ports. There are two butane barges in Holland.

#### What About Federal Control?

Already Federal regulation of natural gas producers seems to be decreasing supplies of natural gas, from which nearly 70 percent of LP-Gas is derived. Latest drilling records show a 12 percent decline in gas well completions in 1955. Also, only 2.3 trillion cubic feet of new gas reserves were committed to large interstate pipelines in 1954, compared with 6.4 trillion in 1953.

If this trend is not halted by passage of the Harris Bill, LP-Gas dealers will be faced with shorter supplies and higher prices.

#### Outlook for 1956

Although LPG sales for 1955 far exceeded the total sales for the first 24 years of the industry, competition in the fuel market still remains keen. The LP-Gas industry must maintain its alertness and initiative if it is to continue to grow.

Weather conditioning, motor fuel and

**Marketed Production of LP-Gas**

| YEAR | Gallons (In Thou.) | Percent Increase | Domestic & Motor Fuel | Percent Increase | Industrial Misc. | Percent Increase | Gas Mfg. | Percent Increase | Chemical Mfg. | Percent Increase | Rubber Components | Percent Increase |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1947 | 2,209,797 | 29.7 | 1,150,538 | 51.7 | 274,125 | 8.0 | 169,332 | 95.4 | 414,267 | 33.0 | 201,535 | —31.4 |
| 1948 | 2,736,801 | 23.8 | 1,473,289 | 28.1 | 275,883 | 0.6 | 237,638 | 40.3 | 524,350 | 26.6 | 225,641 | 11.9 |
| 1949 | 2,836,599 | 3.6 | 1,627,550 | 10.5 | 247,103 | —10.4 | 239,210 | 0.6 | 544,886 | 3.9 | 177,850 | —21.1 |
| 1950 | 3,482,567 | 22.8 | 2,022,464 | 24.3 | 355,456 | (3) | 251,694 | 5.2 | 624,468 | 14.6 | 228,485 | 28.5 |
| 1951 | 4,227,275 | 21.4 | 2,456,804 | 21.6 | 269,408 | (3) | 281,692 | 11.9 | 844,507 | 35.2 | 374,864 | 64.1 |
| 1952 | 4,477,379 | 5.9 | 2,636,736 | 7.4 | 338,959 | 26.0 | 259,697 | — 7.8 | 870,990 | 3.1 | 370,997 | — 1.1 |
| 1953 | 4,932,009 | 10.2 | 2,977,418 | 12.9 | 374,233 | 1.04 | 222,430 | —14.4 | 967,427 | 11.1 | 390,501 | 5.3 |
| 1954 | 5,125,533 | 3.9 | 3,174,012 | 6.6 | 401,615 | 7.3 | 191,932 | —13.7 | 1,050,239 | 8.6 | 307,735 | —21.2 |
| 1955 | 6,006,000 | 17.2 | 3,661,000 | 15.3 | 431,000 | 7.3 | 171,000 | —10.9 | 1,262,000 | 20.2 | 481,000 | 56.3 |

# IF YOU'RE IN A HOLE OVER

# THICKER AND BIGGER SHELLS . . .

## Kellogg's Expanded Fabricating Facilities Can Help You Out

Why let shell geometry present a production bottleneck on urgently needed heat exchangers, towers, and other pressure vessels? M. W. Kellogg's expanded and complete fabricating facilities are geared to produce shells thicker, bigger, and in shorter time than ever before.

Production tools recently installed at Kellogg's New Jersey shop to meet increasing demands for larger vessels include: a planer capable of handling steel plate 40 feet long; huge bending rolls, augmented by a new, ancillary 2,000-ton press for bending plate up to 4 inches thick; and automatic welding equipment for longitudinal seams to 16 feet in length, and circular seams 12 feet in diameter.

In heat treating, Kellogg now can handle vessels larger than a railroad car, with thirteen furnaces having temperature ranges from 1200 to 1950 deg. F. Its pipe bending facilities can shape carbon steel and alloy piping 36 inches in diameter—to exceptionally close tolerances. In nondestructive testing, Kellogg's latest addition is its Kel-Ray* Projector. Using gamma rays, this unique instrument permits the radiographic inspection of welded seams 6 in. thick, 200 ft. circumference, in a single short exposure.

Backing up Kellogg's fabricating facilities are Kellogg engineers, who can either assume entire design responsibility or work closely with your own engineers; and Kellogg's staff of fabricating-welding engineers, who plan and administer a continuing personnel training program to qualify welders and mechanics on new techniques for fabricating new materials.

We welcome the opportunity to demonstrate what Kellogg's complete engineering and expanded fabricating service can do for *you*.

**FABRICATED PRODUCTS DIVISION**

**THE M. W. KELLOGG COMPANY, 225 BROADWAY, NEW YORK 7, N. Y.**

*The Canadian Kellogg Company, Limited, Toronto—Kellogg International Corporation, London*

SUBSIDIARIES OF PULLMAN INCORPORATED

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*Trademark of The M. W. Kellogg Company



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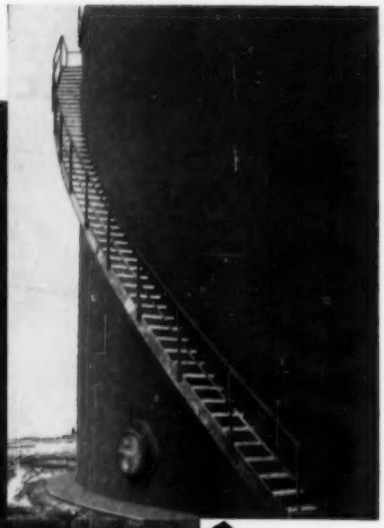
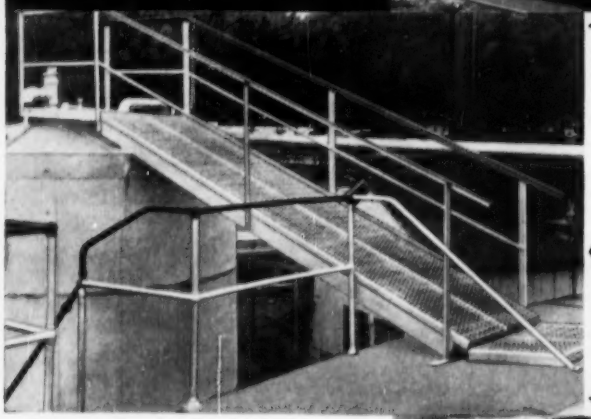
*Use* SAFETY GRIP-STRUT grating

Wherever a safe footing is required





Grip-Strut circular stairway on Shell Oil tank in Portland, Ore.

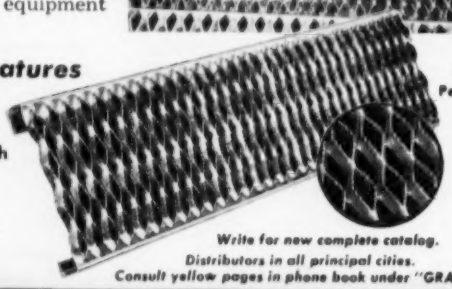
See how Shell Oil uses Grip-Strut for a safe ramp between tanks.

View looking down circular stairway on Shell Oil tank shown above.

**SAFETY GRIP-STRUT** is the new basic material, all in one piece (including channels), not welded, riveted or expanded in steel or aluminum, in standard sizes and gauges. Safety GRIP-STRUT presents an open space, in a diamond pattern, in excess of 55% of the area for ready access of light and air and gives a positive NON-SKID footing in all directions. Ideal for work platforms, stair and ladder steps, flooring, balconies, catwalks, machinery guards, fire escapes and for original equipment safety treads.

***Important Safety Features***

- ★ Fire proof
- ★ Slip proof
- ★ Maximum strength
- ★ Minimum weight
- ★ Easy to stand on
- ★ Cool in summer—warm in winter



Pat. Pending

*Write for new complete catalog.*
*Distributors in all principal cities.*
*Consult yellow pages in phone book under "GRATING"*

GRIP-STRUT division
THE GLOBE COMPANY • *Manufacturers since 1914*
4008 S. PRINCETON AVE. • CHICAGO 9, ILL.


## What's Happening. . .

house heating applications are the markets offering the greatest sales potential for the LP-Gas dealer. LP-Gas for chemical purposes will also continue to increase.

1956 should be another spectacular growth year for the industry.

### Socony Mobil, Houdry Settle Patent Suit

A multi-million-dollar patent suit against Socony Mobil Oil Company, Inc., by Houdry Process Corporation, has been settled out of court. Under an agreement between the two companies, Socony Mobil will pay Houdry $3 million for certain patent rights involving processes and settlement of claims.

The companies will exchange full and complete immunities in the field of moving-bed catalytic cracking for their own operations and for their licensees. They also will have the right to receive, use and pass on to licensees technical information and know-how owned or controlled by either company before December 31, 1955.

The principal processes involved in the suit were the Airlift Thermofor Catalytic Cracking process and the Houdriflow Catalytic Cracking process. The agreement also includes certain improvements in synthetic cracking catalyst and the Houdresid technique.

For any new licenses of the disputed processes granted by Socony Mobil in the next five years, Sonony will pay Houdry $12.50 a barrel of licensed capacity with respect to each paid-up license and three-quarters of a cent a barrel out of running royalties received, until such payments amount to $12.50 a daily barrel of capacity.

### Austria to Compensate For Loss of Refineries

An agreement has been reached with Austria, for full restoration of oil properties owned by U. S. and British interests. Under the agreement, if restoration is not made the companies will be compensated.

Refining companies involved are Socony Mobil Oil Company, Standard Oil Company (New Jersey) and Anglo-Saxon Oil Company. The agreement applies to properties confiscated at the outbreak of World War II or nationalized in 1946.

Lobau refinery will be returned to Socony Mobil and Anglo-Saxon, which indirectly own the plant, or to the jointly-owned Oesterreiche Mineraloelwerke. If transfer is not possible, the Austrian government will make other compensation.

Anglo-Saxon and Jersey Standard will receive compensation for the half interest they owned in the refinery at Korneuburg.

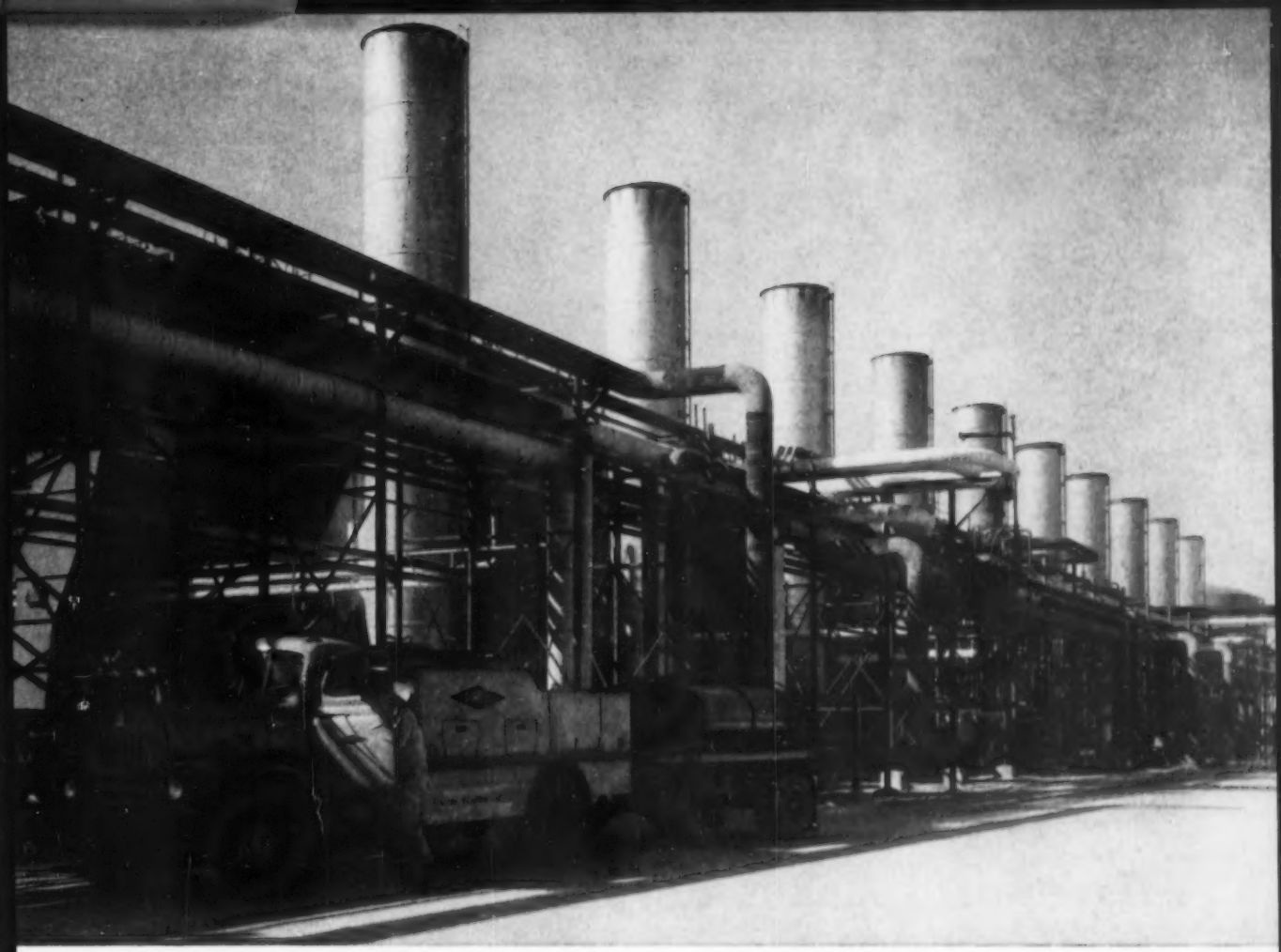
### New Chicago Institute Offers Training in Gas

A new institute has been set up in Chicago, to offer special training in the analysis of gases and vaporizable liquids. Podbielniak Institute, founded by Dr. and Mrs. Walter J. Podbielniak, is already in operation, offering an intensive two-week course for qualified personnel, at its 632 North Dearborn Street location.

The course takes up special instructions in the analysis of natural gas and gasoline.



For more data on advertised products, use Readers' Service Cards, last page.



# OPERATOR SAVED $440,000

## DOWELL chemical cleaning of superheater avoided costly retubing and two-week boiler shutdown

Scale deposits had caused tube failures in the superheater of this 175,000-pound-per-hour boiler. To clean mechanically or replace the tubes would have required a two-week shutdown, costing $1,700 per hour in lost production. Instead, the operator chose Dowell chemical cleaning.

Experienced Dowell engineers developed special cleaning techniques for the nondrainable superheater, then used job-tailored Dowell solvents. The unit was restored to top operating condition in just 3½ days. Total saving to the operator, in cost of outage time and replacement parts, was approximately $440,000!

Dowell engineers hold downtime to a minimum by introducing solvents through regular connections. Extensive dismantling and scaffolding are not needed.

By removing corrosion products, chemical cleaning helps eliminate boiler tube failures due to overheating or galvanic attack. Prevent unscheduled shutdowns . . . keep your equipment operating at top efficiency . . . start a regular program of Dowell chemical cleaning *now*.

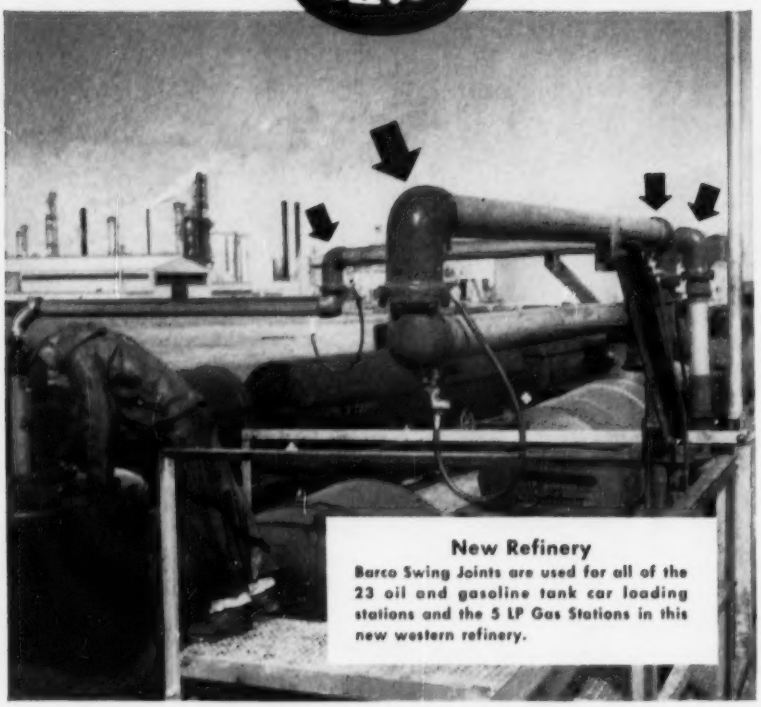
For more information, call any of the 165 Dowell offices in the United States and Canada. Or write directly to Dowell Incorporated, Tulsa 1, Oklahoma, Department **A-31**.

*chemical cleaning service for industry*

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

SWING JOINTS BARCO ASSEMBLIES

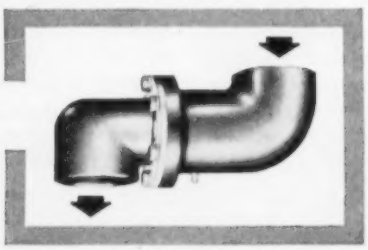


**New Refinery**
Barco Swing Joints are used for all of the 23 oil and gasoline tank car loading stations and the 5 LP Gas Stations in this new western refinery.

# How Barco Makes Refinery Loading Racks Work Better!

1. **Controlled Torque**—Here is a feature users unanimously applaud in Barco's new Swing Joints—*no annoying, uncontrolled free swinging of lines.* They swing easily but stay put.
2. **Ball Bearing and O-Ring Equipped**—Designed specifically for handling gasoline, oil, lube oil, LP gas, and other fluids, including many chemicals, *without leakage.*
3. **Large Bearing Surface**—Barco's bearing design provides adequate support for lengths of piping. Minimizes bearing pressures and wear.
4. **Long Life**—New "Bar-Moly" dry lubricant process used by Barco gives a permanent anti-galling, corrosive-resistant finish to moving parts. This, combined with routine lubrication, insures longest possible maintenance-free service.
5. **Easy Maintenance**—Joints can be disassembled for inspection without disconnecting piping. O-rings are easily renewed in the field. Frequent greasing not required to maintain sealing.
6. **Custom Designed Installations**—Your Barco Representative will be glad to show you actual models of smooth-working, balanced assemblies and a wide choice of Barco custom designs. Choice of materials, including all-steel. Sizes 1", 1½", 2", 2½", 3", 4", 6", and 10"—eleven different styles of joints. Ask for Catalog 400.

**BARCO**
*Manufacturing Co.*
542B NORTH HOUGH STREET
BARRINGTON, ILLINOIS
*Worldwide Sales and Service*



## What's Happening. . .

petroleum and its products. This includes products turned out by both refining and petrochemical processes. Also in the course are similar complex gases and vaporizable liquids, using such apparatus and techniques as low- and high-temperature analytical distillation, vapor-phase chromatography and other supplemental methods.

Plans call for the institute to serve as a central reference and clearing house for the exchange of information on the methods of analyzing gases and vaporizable liquids. The staff also will study industry problems, and cooperate with analysts in developing improved techniques.

The institute will be self-sustaining, but it will be essentually non-profit.

### Refinery Investments Continue to Climb

The petroleum-refining industry is due to invest $697 million in new plant and equipment during the first three months of 1956. According to Department of Commerce estimates, this amount will represent a 40 percent increase over the $490 million spent for refinery expansion during the same quarter of 1955.

The department has fixed a total of $2,756,000,000 as the amount spent on equipment to process petroleum and coal in 1955. Of this amount, about 95 percent was used to buy petroleum-processing equipment. The figure represents an increase of $72 million over 1954 and $88 million over 1953.

Estimates show that refinery expansion ran almost 10 percent of the $28,268,000,000 invested in all U. S. industries last year. That figure, while $1,441,000,000 more than the amount reported for 1954, is $54 million less than the amount spent in 1953.

### Ohio Oil to Close Wyoming Refinery

The Ohio Oil Company will suspend operations at its Lovell, Wyo., refinery sometime after August 1, 1956. The limited market in the Rocky Mountain region and the high cost of moving finished products to other areas were given as reasons for the close down.

The company started operations at the Lovell refinery in 1937, using it as an asphalt plant to provide an outlet for production in the Big Bend basin. The refinery served this purpose for a number of years.

For the past two years, however, it has been operating at less than half capacity. The plant, with a daily capacity of 6500 barrels, has been refining an average of 3000 barrels a day.

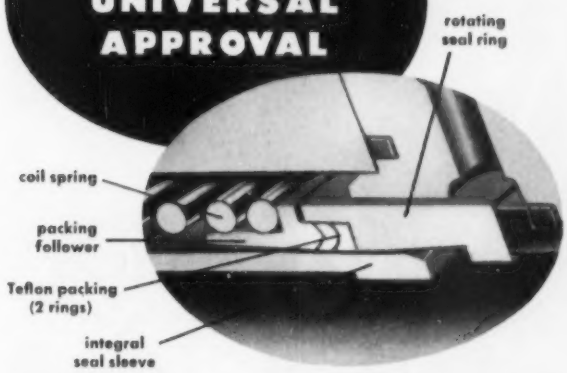
No decisions have been made for disposing of the plant. It may be sold in place or dismantled.

The refinery is one of two operated by The Ohio Oil Company. The company's larger refinery, with a capacity of 40,000 barrels a day, is at Robinson, Ill., and serves the company's primary marketing area.

### Honolulu Refinery Sold

Stockholders of Pacific Refiners, Ltd., have voted to accept Standard Oil Company of California's offer to buy the company's Hawaii refinery. The plant, at

# THE SEAL WITH UNIVERSAL APPROVAL




**SEALOL-FLEXIBOX TYPE RRV SEALS** have received enthusiastic approval from operators of oil refinery process pumps who rely upon the design features of these mechanical seals to provide minimum maintenance and drip-free operation. These Flexibox seals . . . by eliminating gland leakage . . . prevent valuable product loss . . . and do away with fire hazard conditions created by escaping volatiles. The extreme simplicity and sturdiness of these seals make them equally adaptable to existing pump or new pump applications . . . and popular with maintenance personnel because of assembly ease . . . requiring no adjustments or set screws. The Teflon® packing maintains sealing contact by positive mechanical means . . . which automatically compensates for dimensional changes due to temperature and pressure variations.

Flexibox versatility has been proven in such applications as . . .

- **acid sludge • 90 psig • 140°F**
- **50% nitrogen — 50% steam • 160 psig • 340°F**
- **sulphuric acid • 40 psig • 125°F**

. . . and thousands of others. If you desire complete data on Sealol-Flexibox seals send for Bulletin 10, or request engineering recommendations for your particular problems. Join the many world famous refineries and pipeline companies who have standardized on Sealol-Flexibox Mechanical Shaft Seals.

**SEALOL CORPORATION,**
**185 POST ROAD, PROVIDENCE 5, R. I.**

New York • Philadelphia • Cleveland • Chicago • Norfolk
Charleston (W. Va.) • St. Louis • Kansas City • New Orleans • Dallas
Houston • Tulsa • Los Angeles • San Francisco • Seattle • Edmonton
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**SEALOL**

THE BALANCED PRESSURE SEAL

# It's Top's

## . . . for quick clean cuts

7 cutters for ⅛″ to 6″ pipe.

## . . . the efficiency-balanced

# RIDGID

## Heavy-Duty Pipe Cutter

Powerfully built—guaranteed not to warp or break, always tracks perfectly . . . Famous RIDGID thin-blade or heavy-duty cutter wheels of tool steel roll easily, cleanly through any pipe.* Every cutter factory-tested! Buy them at your Supply House.

*Special wheels available for stainless steel and cast iron.

**For fast easy pipe cutting in tight places, RIDGID 4-wheel cutters.**

**RIDGID**
**Work-Saver Pipe Tools**

**The Ridge Tool Company, Elyria, Ohio, U.S.A.**




For more data on advertised products, use Readers' Service Cards, last page.

PATENT PENDING

**Ducon** **TRICKLE VALVE . . .**

***the first dip-leg SEAL with approval for fluid catalyst cracking plants***

The good word "APPROVED" gets around the industry fast. Through research and experience in application of their type SDC recovery cyclones, The Ducon Company offers a truly dependable dip-leg seal for catalyst cracking plants. The unit permits instant attainment of operating conditions with minimum loss of catalyst. A free-swinging ring type hinge assures true alignment of those surfaces affecting the gas seal . . . and offers no resistance to movement of the valve plate by the returning catalyst. The fact that the refining industry must maintain continuous operation for greatest efficiency . . . has won immediate approval for the Ducon trickle valve as a trouble-free seal.

***Write today for full details***

*the* name in dust control

THE **Ducon** COMPANY

147 EAST SECOND STREET, MINEOLA, N.Y. • Sales Representatives in Principal Cities

Canadian Branch: THE DUCON COMPANY of CANADA, Ltd.
275 James Street North, HAMILTON, ONTARIO

***Designers and Manufacturers of Dust Control Equipment Exclusively***

**CYCLONES • CENTRIFUGAL WASH COLLECTORS • TUBULAR CLOTH FILTERS • DUST VALVES**

Honolulu, has been turning out asphalt, aromatics and bottled gas. It will go to Standard for $2,425,000.

The sale was prompted by Standard's plans to build a 25,000-barrel-a-day refinery there. The new plant, to be built on Sand Island in Honolulu harbor, is expected to cost some $30 million.

**A New Development**

**This picture illustrates a new method for testing the color of aviation gasoline. Developed by Ethyl Corporation in conjunction with Hellige, Inc., the method makes use of ten permanent color standards mounted in two discs. Each pair of these standards provides the minimum and maximum intensity for the standard colors—red, blue, green, brown and purple—used in aviation gasoline grades.**

**To test for color intensity, a sample of the finished gasoline is placed alongside a sample of the uncolored base stock in a color testing device. A color testing disc is inserted above the uncolored base stock sample, and a beam of light is directed upward through the sample and the color standards. A visual inspection of both samples quickly determines whether the finished sample falls within the maximum and minimum color specifications.**

## Indiana Standard Sets A Record in Safety

A new world's record for laboratory safety has been set by Standard Oil Company (Indiana) research workers at Whiting, Ind. They have worked more than 7,200,000 man-hours without a lost-time accident.

According to records of the National Safety Council, the best previous record for a similar laboratory was slightly less than 7,190,000 man-hours, set by a large chemical concern. There are 1200 workers in the Indiana Standard research system.

## Negotiating Merger

American Cyanamid Company is negotiating for the purchase of The Formica Company. The proposed acquisition, details of which are still under negotiation, contemplates that Formica will continue to operate under its present management, as an additional unit of the Cyanamid organizations. Final agreement will be subject to the approval of the Cyanamid board and the stockholders and directors of Formica.

## Copies of Index Still Available

Copies of the 1955 PETROLEUM REFINER Index, which in the past always has appeared in the December issue, are still available to subscribers—now upon request. Readers who want this valuable guide to the past year's advancements in refining, petrochemicals and natural gasoline should use the Reader's Service blue card in the back of this issue. Write on the card, "1955 PETROLEUM REFINER Index," fill in name, address and mail. There is no charge or obligation.

## What's Happening. . .

### Japanese Refineries To be Insured in U. S.

Japan Oil Refining Company, affiliated with California Texas Oil Company, will sign a damage-insurance contract worth nearly $22 million with an American insurance company after its contract expires shortly with seven Japanese firms.

Coverage with the U. S. concern would cost about 1.15 yen per 1000 yen (360 yen to $1) against 15 yen per 1000 by Japanese insurance companies. Under the lower rates, the refining company's insurance cost would amount to only $25,000


FLOREX

A *Sure* Cure for the Platinum "*BLUES*"

The growing use of platinum catalysts in reforming feed stock emphasizes the importance of pre-removing trace metals such as arsenic, lead and sulphur compounds. Platinum catalysts are poisoned by these substances in quantities even as small as ten parts per billion.

Treating the feed stock before the trouble occurs, Florex adsorbent provides the simplest, most economical means to protect expensive catalysts. Florex in the granular grades will completely remove or reduce these compounds to a harmless level.

Recognized throughout the world as superior to all other natural clays, Florex is prepared from carefully selected Florida Fuller's Earth by a special processing, including high pressure extrusion.

Meshes from 8/16 and up are customarily used. Write for information today.

FLORIDIN COMPANY

Adsorbents
Desiccants
Diluents

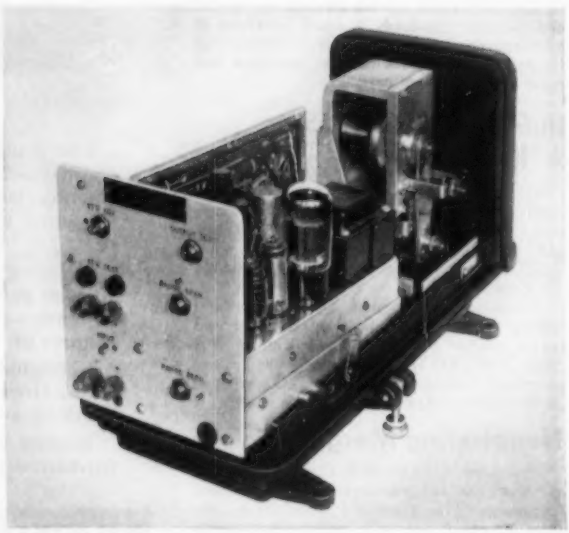
Dept. E Box 998, Tallahassee, Florida




For more data on advertised products, use Readers' Service Cards, last page.

# *Now!* A TAYLOR

**Plugging in the Transducer.** This exclusive plug-in feature applies to both the transducer and the amplifier. Means quick, easy removal for service; minimum instrument down-time; checking can be done in the shop where full facilities are available. Also permits separate calibration.



**Plugging in the Amplifier.** See how easily units are locked into the chassis. Also note screwdriver adjustment of range span and zero suppression by virtue of unique potential dividers. Exclusive Taylor vernier adjustment permits resolution of 1 part in 100,000.



For more data on advertised products, use Readers' Service Cards, last page.

# POTENTIOMETER TRANSMITTER

## with all the innovations, ruggedness, dependability and versatility that industry expects from Taylor

TAYLOR has broadened its base of measurement with the introduction of an electronic instrument that extends the versatility of its pneumatic controllers and receivers. The TRANSET* Potentiometer Transmitter is a completely adaptable instrument for the measurement of a wide variety of variables, and can be quickly modified for use with different electrical primary elements. This ingenious instrument reflects Taylor's years of experience and knowledge of the requirements of the processing industries.

The TRANSET Potentiometer is especially adaptable where processing conditions require pneumatic controllers and receivers, and where conventional measuring circuits have not proved adequate. In thermocouple applications, for example, it can accurately measure temperatures within limits of minus 320°F. to plus 3272°F., with range spans as short as 100°F., depending upon the characteristics of the thermocouple used.

*Reg. U.S. Pat. Off.

**Plugging in the Input Circuit Board.** It can be quickly adapted for use with different primary elements by simply plugging in the corresponding input circuit; e.g., for thermocouple applications cold junction compensation is provided in the plug-in circuit board. One instrument can therefore be used as a spare wherever a transmitting potentiometer is used.

### Why experienced instrument men say— "most practical instrument of its kind"

**1.** The unit is automatically, continuously standardized and offers complete electronic balance, permitting optimum response adjustments. There are no slide wires or motor drive.

**2.** High Input impedance. No need to match resistance of leads.

**3.** Output impedance is virtually infinite. Its 0 - 5 milliamp signal can perform multiple auxiliary functions without affecting accuracy of pneumatic signal.

**4.** Range span and zero suppression adjustments are easily made by screwdriver due to unique design of high resolution potential dividers.

**5.** Both electronic and pneumatic units plug-in. Simplifies service; permits separate calibration.

**6.** Normal load is automatically inserted when amplifier is removed for service.

**7.** Modern printed circuits insure uniform performance. Test terminals provided for trouble shooting.

**8.** Three-circuit jack on front panel permits easy monitoring of output current. Convenient pin jacks provided for checking standardization voltage.

**9.** Three-piece, purged cast-aluminum case is moisture and corrosion proof. All adjustments are readily accessible.

**10.** If used only for scanning, logging or similar auxiliary functions the instrument is available without transducer.

**Write for Bulletin 98262.** Taylor Instrument Companies, Rochester, N.Y., and Toronto, Canada.

*Taylor Instruments*
MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY



For more data on advertised products, use Readers' Service Cards, last page.

## What's Happening. . .

for about $22 million worth of insurance, whereas the cost would run about $333,-333 with Japanese firms.

Caltex, which has more than 90 plants in some 60 countries, has taken out insurance with U. S. firms and the Japanese refinery was merely added to the list. The Japanese refining company has two refineries—one at Yokohama and the other at Kudamatsu. Capitalized at $11 million, it is expanding its facilities with a $16.5-million investment made two years ago.

### British Engineers Study Automation at Cambridge

Ten engineers from various British industries, including petroleum refining, are back in school—this time to study automation. At Cambridge University, they are taking part in Britain's first full-scale course in control engineering and the problems of automation.

One of the contributors to the experimental course was The British Petroleum Company. Among the students at the present course is J. M. Keating, chief instrument engineer at the company's Llandarcy, South Wales refinery.

Studies include the principles of automatic control of operating plants, making machine tools, the use of computors for reckoning accounts and planning production. During the one-year course, students will make a number of visits to plants where automatic control is being used.

### Illinois Refinery Completes Million Accident-Free Hours

Running up a combined score of more than a million accident-free man-hours, two departments of The Ohio Oil Company's Robinson, Ill., refinery here have received national recognition for their safety record. Presented to the refinery laboratory and barrel house, each API Accident Prevention Award was for over a half-million man-hours worked without a disabling accident.

Acting in behalf of the API, H. E. Handy, refinery manager, delivered the awards to Harley E. Burkhart, laboratory supervisor, for 672,000 man-hours without a disabling accident, and to Arthur E. Slawson, Barrel House foreman, for 520,-000 man-hours.

The refinery has received plaques from both the API and the National Safety Council for accident prevention. In 1950, it was cited for 2,423,961 safe man-hours worked in the entire plant. In 1951, the Still Maintenance Department was given the API's million-man-hour award for 1,-129,191 man-hours. The refinery Electrical Shop was recognized in 1950 for going 19 years without a disabling accident.

During the last five years, Ohio Oil's Refining department won National Safety Council awards in 1950, 1952 and 1954.

### Britain's Output Up

Great Britain's refinery output in 1955 totaled about 580,000 barrels a day. It was nearly 560,000 barrels a day in 1954, and less than 60,000 barrels in 1947.

### Two Fast Write-Off Certificates Approved

Office of Defense Mobilization has issued fast tax write-off certificates for two more petroleum projects, including a $25-million expansion project by Tide Water Associated Oil Company at San Francisco.

Tide Water was cleared for 65 percent on $17,855,000, 45 percent on $6,120,000 and 15 percent on $70,000. The San Francisco project calls for the installation of a 42,000-barrel-a-day coking unit, hydrodesulphurization equipment rated for 20,000 barrels a day, and the expansion of the refinery's catalytic-cracking capacity.

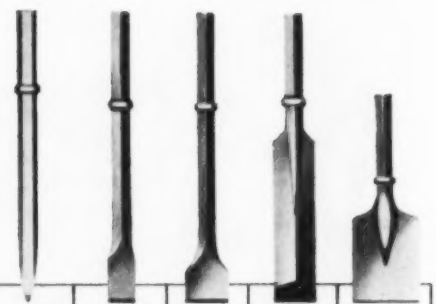
Aurora Gasoline Company received a certificate for 65 percent on $652,125, covering a new catalytic reformer and expansion of office facilities at its Detroit refinery. The reformer, already completed, was built for a daily capacity of 6000 barrels.

### Premium Closed Year With 96.1 Octane Average

Gasoline on sale at service stations in December closed out the year with an average octane number of 96.1 for premium and 88.9 for regular on a national weighted basis, according to a survey by Ethyl Corporation.

The premium gasoline average was unchanged from November but 1.8 octane numbers higher than in December 1954. The regular gasoline average was 0.1 octane number higher than in November and 1.6 octane numbers above December 1954. The premium average gained in all but

play it safe
with IR SPARK RESISTANT
PAVING BREAKER TOOLS



These FORGED beryllium copper tools stay sharp longer . . .
yet provide maximum protection against spark hazards

● Now, with this new line of Ingersoll-Rand beryllium copper tools, you can play it safe . . . and still get far greater tool life than ever before obtainable with this type of equipment. That's because I-R tools are FORGED — not merely cast — of a special, high-strength beryllium copper alloy. A trial order will quickly demonstrate their superiority over any spark-resistant paving breaker tools you have ever used. It will pay you to see your nearest I-R representative about this as soon as possible.

| SHANK SIZE, HEX. | MOIL POINTS | NARROW CHISEL BITS | 3" CHISEL BITS | 3" x 12" DIGGING CHISEL | 5" ASPHALT CUTTER |
|---|---|---|---|---|---|
| 7/8" x 3¼" | X | X | X | | |
| 1" x 4¼" | X | X | X | | X |
| 1 1/8" x 6" | X | X | X | X | X |
| 1¼" x 6" | X | X | X | X | X |

Ingersoll-Rand
11 BROADWAY, NEW YORK 4, N. Y.

S-229




For more data on advertised products, use Readers' Service Cards, last page.

Can I use this sheet packing on hot oil lines, too?
Johns-Manville
SERVICE
Sure J-M Service Sheet is equally good for oil, steam and gas lines!

**Your J-M Packings Distributor can tell you why this quality sheet packing has maintained such an excellent reputation for over 35 years**

**Where it's used:** Every industrial plant can use J-M Service Sheet Packing to advantage. It's the favorite packing of thousands of plant engineers and maintenance men. Both versatile and dependable, Service Sheet makes a tight, long-lasting seal against superheated steam, air, gas, water, hot oil and ammonia, as well as many acids and chemicals.

**What its advantages are:** J-M Service Sheet is a quality packing, made of selected long-fibre asbestos bonded with heat-resisting compounds. It is graphited on one side to permit breaking a joint without destroying the gasket. The ungraphited side is ruled into one-inch squares to speed cutting and reduce waste. And . . . you can order it in large economical quantities because J-M Service Sheet will not dry out in stock!

**How it is furnished:** Service Sheet is supplied in sheets 54″ x 63″, 36″ x 126″, 36″ x 63″, and 54″ x 126″ sheets in thicknesses of 1/64″ to ¼″ and 108″ x 126″ sheets in thicknesses of 1/32″ to ¼″. It is also furnished as cut gaskets in standard and special shapes. See the J-M catalog for further details.

**Your J-M Packings Distributor** carries complete stocks of J-M Service Sheet and other quality Johns-Manville Packings. He can help you choose the right packing for your application. Write him for complete information and copy of folder PK-19A, "Thousands of Plants Rate It Tops." Or address Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay Street, Toronto 1, Ontario.

JOHNS-MANVILLE JM PRODUCTS

**Johns-Manville PACKINGS & GASKETS**

**A KERRIGAN**
**Grating for Every Need**

**A CATALOG**
**for every Grating**

***Write for your***
***Copy* NOW!**

**STEEL**
*for the 1001 applications where safety and strength come first. Kerrigan Steel Grating is BONDERIZED for corrosion resistance and extra years of life.*

**STAINLESS and MONEL**
*non-magnetic steel for the chemical, oil and packing industries . . . for ANY installation where high resistance to heat, acids, chemicals, and corrosion is needed.*

***TRULY . . .***

In both size and type, there is a Kerrigan Weldforged grating for every need. Let our new catalogs prove it to you. Send for the one you think best answers your need (or ask for ALL FOUR if you wish). We will also be glad to send you a desk-size grating sample. Write Kerrigan Iron Works, Inc., General Sales Office, 274 Madison Ave., New York City.

**RIVETED STEEL**
*where it is desired to match existing grating.*

**ALUMINUM**
*spark-proof for those whose need is strength AND lightness. Extra safe and strong. Allowable fiber stress 15,000 psi. Modulus of elasticity 10,000,000 psi.*

**KERRIGAN GRATING**
**CUSTOM-MADE FOR YOUR JOB AND SAFE—IT'S Weldforged**


## What's Happening. . .

three months of 1955 while the regular average increased in eight of the 12 months.

Thirty of the 53 cities covered by Ethyl's survey reported increases over November in the average octane number of their premium gasolines, with five cities showing a monthly gain of 0.5 octane number or more. Fourteen cities reported decreases while nine cities were unchanged.

In regular gasoline, 34 cities reported increases in their average antiknock quality, seven of them by 0.5 octane number or more. Thirteen cities showed a decrease from November while six cities were unchanged.

Against the nationwide premium average of 96.1 octane number, 19 cities reported premium averages of 96.5 octane number or higher. In regular gasoline, 15 cities showed average octane ratings of 89.5 octane number or higher, compared with the national weighted average of 88.9 octane number.

### NGAA to Sponsor Liquid-Analysis Project

A new program of industry-wide comparative analysis of liquid hydrocarbon samples having known compositions will be sponsored by the Natural Gasoline Association of America.

The next sample, No. 7 in the liquid series of the past four years, will be a deethanized natural gasoline containing components from propane through hexanes-plus and is now being blended synthetically from pure grade hydrocarbons by the Special Products division of Phillips Petroleum Company at Bartlesville, Okla.

The sample will be distributed to the 102 oil company and commercial laboratories in the U. S. and Canada which participated in the previous studies.

Other laboratories desiring to check their own results against the laboratories already in the program may participate. Inquiries should be directed to the NGAA offices, 421 Kennedy Building, Tulsa 3, Okla.

### Texaco Technical Service Opens Atlanta Office

The Texas Company's Research and Technical department is expanding the activities of its Technical Service division, by opening a new regional office in Atlanta, Ga. The new center is expected to give southern industry quicker access to Texaco's technical services as well as its research facilities.

A nationwide technical service has been maintained by Texaco for a number of years. Its first technical service office was opened in Houston in 1922. Other offices now are in Detroit, Los Angeles, Chicago, Pittsburgh and New York.

### Cleared for AEC Data

Phillips Petroleum Company has been added to the list of oil companies with access to restricted Atomic Energy Commission data.

### Middle-East Naphthas Making High-Octane Blend

A Platforming unit at one of The British Petroleum Company Ltd., refineries is producing a 92-plus F-1 clear blending component by processing Kuwait naphtha. This


For more data on advertised products, use Readers' Service Cards, last page.

# PRE-TESTED!

## CHASE® ANTIMONIAL ADMIRALTY HEAT EXCHANGER TUBES

*are made to last years longer!*

All the hydrostatic tests, corrosion tests, expansion and flattening tests which go on at the Chase mills are designed for one thing—to assure *years* of extra service from Chase Antimonial Admiralty Heat Exchanger Tubes.

But the real test takes place right on the job—where stresses, strains and corrosion are at their very worst. Chase Antimonial Admiralty Heat Exchanger Tubes pass *that* rugged trial with flying colors!

It follows that the longer heat exchanger tube life you get from Chase Antimonial Admiralty *also* means lower operating costs, fewer breakdowns and more time between tube replacements!

Get the benefit of extra years of service—insist on Chase Antimonial Admiralty!

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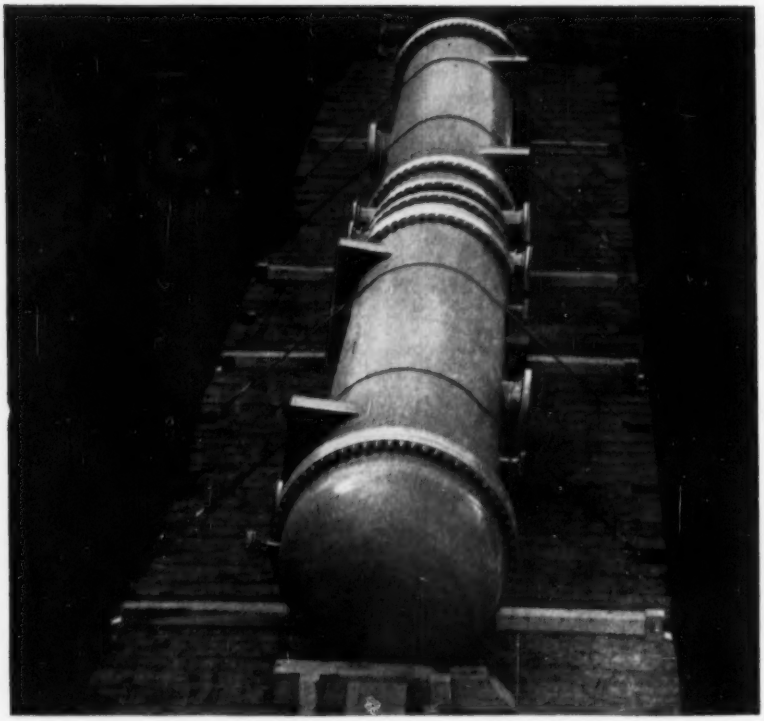

## Supersonic testing adds extra value to refinery condensers by Downingtown

Supersonic testing...centrifugal casting...stress-relieved welding of Ampco 8...are some of the advanced techniques specified by Downingtown engineers in designing these two 42″ x 16′ inside floating head propane condensers. Essential cost savings resulted, and the condensers are highly corrosion-resistant.

Units meet ASME Code and TEMA Class R requirements in every respect. Ampco 8 was used extensively because of its higher allowable design stresses at elevated temperatures. Design pressure is 275 psi on the shell side and 100 psi on the tube side.

Each unit has 1320 Cupro-Nickel tubes ¾″ O.D. x 16′ 0″ long. Tube sheets are of Ampco 8. The channel—a centrifugal casting of Ampco 8—was supersonically tested to assure soundness. Channel cover is of Ampco 8 lined steel. Shell and shell cover are of ¾″ carbon steel. Inside floating head is a centrifugally cast Ampco 8 flange welded to a 40″ I.D. x ¾″ Ampco 8 head. All Ampco 8 weldments were heat-treated after welding to increase resistance to corrosion by relieving internal stresses set up during welding.

Write for further information on Downingtown experience in designing and fabricating heat exchangers and other pressure vessels for the refinery. Heat treating and X-ray testing as required by specifications.

**Downingtown Iron Works, Inc.**
Downingtown, Pennsylvania
New York Office: 52 Vanderbilt Avenue, New York 17, N. Y.

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Division of: Pressed Steel Tank Company, Milwaukee 14, Wisconsin • Manufacturer of Hackney Products
CONTAINERS AND PRESSURE VESSELS FOR GASES, LIQUIDS AND SOLIDS


## What's Happening...

high-octane number is on a butane-free reformate without the addition of tetraethyl lead.

Industry observers believe this is the highest octane level obtained to date from a Middle East naphtha in commercial operation.

The unusual performance is being achieved with a standard R-5 Platforming catalyst produced for BP in the Universal-Matthey Products, Ltd., plant near London. The present run producing this high-octane blending component has been on stream nearly two months, and the run is continuing satisfactorily.

The results are noteworthy because of the type stock being processed. Kuwait and other Middle-East stocks are of a high-paraffinic nature, and represent the most difficult naphtha to upgrade to virtually "super" F-1 clear-octane levels.

### Goodrich-Gulf Bids High For Institute Rubber Plant

The government, selling the last of its synthetic-rubber facilities, has received a bid of $11 million from Goodrich-Gulf Chemicals, Inc. This was the highest of six bids submitted for the government's Institute, W. Va., plant.

The sale of Goodrich-Gulf would be subject to review by Congress and the Department of Justice. Attorney General Brownell will report his finding to Congress January 13.

If Congress does not object to the sale within 30 days, Goodrich-Gulf will take over the plant in mid-February. Terms of the sale will be announced when the attorney general's report is sent to Congress.

The plant, built in 1942 at a cost of $18,403,350, has an annual capacity of 122,000 tons. In June 1955, the government figured its book value after depreciation at $5,130,000. It is the largest of the synthetic-rubber plants built by the government during World War II.

The other companies which submitted bids were Imperial Commodities Corporation, a Dutch-owned firm; United Rubber & Chemical Company; Goodyear Synthetic Rubber Corporation; Union Carbide and Carbon Corporation, and Edwin W. Pauley, California industrialist.

### Burning Rubbish Reported As Contamination Source

A one-year research project of the independent Air Pollution Foundation, conducted by Battelle Memorial Institute, points to an air contaminant which may not be a contributor to smog, but could be injurious to health. That suspect is phenol.

A study of the emissions from typical backyard burners shows that for every ton of rubbish burned, more than eight pounds of the emissions are phenols.

An aerometric survey conducted by the foundation in Los Angeles County last year showed that phenol constituents in the atmosphere were higher in Pasadena than elsewhere in the basin, and that the only source of phenols was the burning of rubbish.

Aldehydes, such as formaldehyde, appeared in concentrations of from 5 to 64 pounds a ton of rubbish burned, while hydrocarbons appeared in a range of 44 to 293 pounds a ton. Hydrocarbons and aldehydes are suspects in the formation of eye irritants in the Los Angeles atmosphere.

# Permutit Deaerators cut corrosion costs

**WORLD'S LARGEST** double-unit Deaerating Heater is in a large Texas refinery. These Permutit twins heat and deaerate makeup at the rate of 3,000,000 lb/hr. They completely remove oxygen and free $CO_2$ to prevent corrosion and costly replacements of tubes, piping, pumps, valves.

*Exclusive reboiling spray design!* The first of these twin units proved itself with 13 years of *better-than-guarantee performance*—often at 115% of rated capacity. Seventeen field-performance tests show *oxygen reduced to 0.0 ml/l . . . free $CO_2$ cut to zero!* Reasons: Permutit's design provides violent boiling, vigorous scrubbing—for both light and heavy loads.

*Free Technical Bulletins!* Write today for data to help you select your next Deaerating Heater or other types of Water-Conditioning Equipment. The Permutit Company, Dept. PR-1, 330 West 42nd St., New York 36, N. Y.

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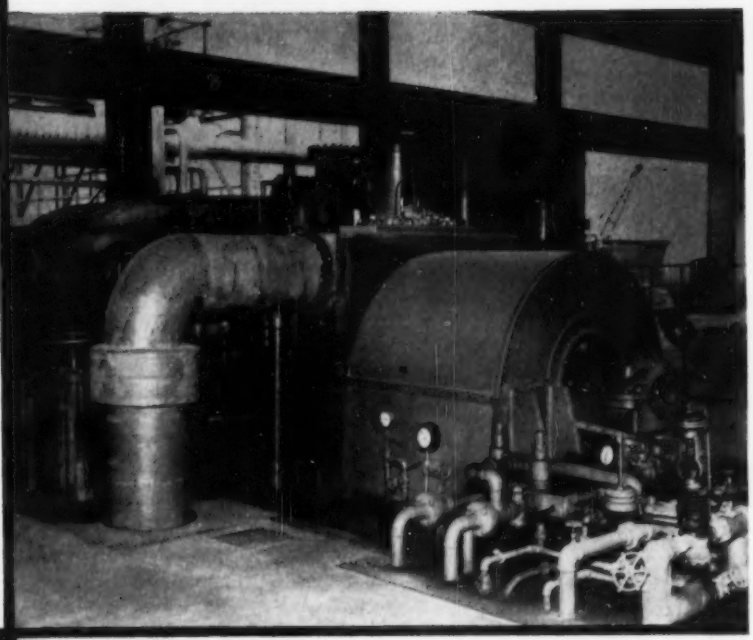
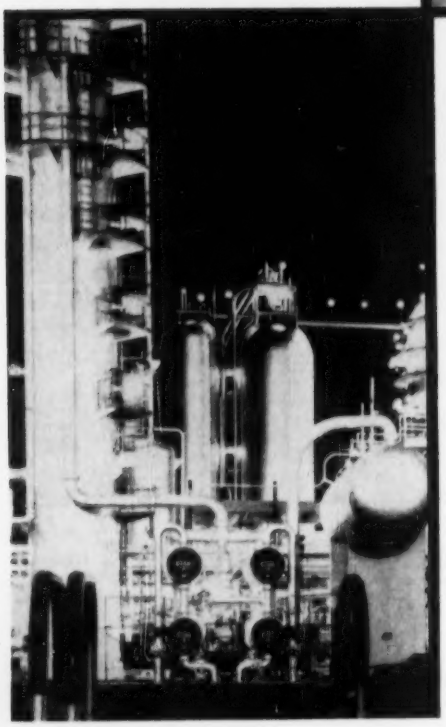
ROSS

# ROSS EXCHANGERS cool lube oil for I-R turbo-blowers at giant Esso cat cracker





Compressing 52,000 cfm of air for catalyst blowing in Esso's giant Bayway, N. J. cat cracker — one of the world's largest — this Ingersoll-Rand Turbo-Blower (one of two) is driven by a 4530 hp I-R Turbine.

To protect bearings and other vital parts with temperature-safe lubrication, twin Ross Type CP Exchangers were factory-furnished with each unit. Dependable oil cooling is continually assured!

At work in refineries around the world, Ross Exchangers not only serve engines, compressors and other primary equipment, but also the more specialized distillation units themselves — wherever there is a heating, cooling or condensing requirement. Top rated for thermal efficiency and ruggedness, they're the No. 1 choice of machinery builders and refiners alike.

Easy to install and easy to maintain, Ross Exchangers are pre-engineered, fully standardized and promptly available in a wide range of designs and sizes to meet your needs, *no matter how special!*

For detailed information, request Bulletins 1.1K5 and 2.1K5.

**ROSS HEAT EXCHANGER DIVISION**
of
American-Standard
**1419 WEST AVENUE • BUFFALO 13, N. Y.**
In Canada: Kewanee-Ross of Canada Limited, Toronto 5, Ont.

# What's Happening . . .

## . . . *Among Men* in the Industry

**Jan G. Schaafsma** has been appointed manager of the Laboratories department of General Petroleum Corporation. Schaafsma joined General Petroleum in 1934. He was appointed assistant manager of the Vernon, Calif., laboratories in 1954 and had been acting manager for the past six months. A registered chemical engineer, he holds a patent on a treating process for petroleum and is the author of several technical articles.

**Walter R. Bimson,** Phoenix, Ariz., banker, has been elected to the board of Stanford Research Institute. He becomes the organization's 39th director. Bimson also is president of Arizona Bancorporation and director of that and a number of other companies. He is a member of the U. S. Chamber of Commerce's Economic Policy and Small Business Advisory committees.

**J. W. Palmer,** senior chemical engineer at Stanolind Oil and Gas Company's Research Center in Tulsa, has been elected chairman of the AIChE section there. He succeeds **Bert J. Thompson,** with Warren Petroleum Corporation.

**T. Ed Griffith,** supervisor of gas and gasoline operations in Tide Water Associated Oil Company's Central division, was named vice president, and **H. L. Lawler,** mechanical engineer with Stanolind, was elected secretary-treasurer.

**Curtis M. Klaerner,** manager of Socony Mobil Oil Company's Buffalo, N. Y., refinery, has been made assistant general manager of operations for the Manufacturing department, headquartered in New York. He will be succeeded at Buffalo by **T. C. Lockhart,** now manager of the Light Oils Operation division of the Manufacturing department in New York.

Klaerner joined Magnolia Petroleum Company, southwestern affiliate of Socony Mobil in 1942, and became manager of the Buffalo refinery in 1954. Lockhart, with the company since 1936, started at the Paulsboro, N. J., refinery; he has been at his present New York post since 1953.

**G. L. Parkhurst,** a vice president of Standard Oil Company of California since 1949, has been elected to the board of directors. Previously president of the subsidiary Oronite Chemical Company, Parkhurst also is a director of Arabian American Oil Company and Trans Arabian Pipe Line Company. Before World War II he was in the oil business in the Middle West, and during the war he served with the Petroleum Administration for War. He joined Oronite in 1946.

Parkhurst

**Cited for Heroism—**

**Two Sun Oil Company employes have received the petroleum industry's gold medal for heroism in saving the life of a fellow employee who came in contact with a 2300-volt line. Representing top recognition by the API, the awards were presented to John T. Murphy and John R. Viscidy (at right) by Sun President Robert G. Dunlop (extreme left) and C. H. Thayer, Sun's vice president in charge of manufacturing. Both recipients are electricians at Sun Oil's Marcus Hook, Pa. refinery.**

Morris Henderson Boyce

**Lee Morris,** with Standard Oil Company of California and its subsidiaries since 1941, has been named manager of operations at the new American Gilsonite Company plant being erected near Grand Junction, Colo.

Also receiving top assignments at the new refinery are **John H. Henderson, Jr.,** named as chief engineer of operations, and **Jesse L. Boyce, Jr.,** who will be refinery superintendent.

Morris was refinery superintendent and later assistant manager of the Vancouver, B. C., refinery of Standard Oil of British Columbia. Henderson has been serving California Standard in the design and construction of pipe lines and refineries, and Boyce has been with the company in operations and design work.

**Harry B. McClure,** president of Carbide and Carbon Chemicals Company, has been picked to receive honorary membership in the American Institute of Chemists. During the past 20 years, he has served his company successively as manager of its Fine Chemicals division, vice president, executive vice president and, since 1954, as president.

**Jack C. Dart** and **Alex G. Oblad** have been made vice presidents of Houdry Process Corporation, and Dr. Oblad was elected to the board of directors. Dart, already a member of the board, is general manager of the company's Chemicals division, and Dr. Oblad is manager of research and development.

A former manager of research and development, Dart holds patents in alkylation, hydrocarbon synthesis and catalytic cracking of petroleum fractions. Dr. Oblad who recently became chairman of the ACS's Petroleum Chemical division, holds more than 20 patents in catalysis. He is a consultant to Catalytic Construction Company.

**David J. Stark** has been elected vice president of Escambia Bay Chemical Corporation. He is plant manager for the company, which is building a petrochemical plant near Pensacola, Fla. Stark joined Escambia Bay early in 1955, after having served as manager of the National Petro-Chemical Corporation plant at Tuscola, Ill. Before that he was chief technologist and department manager in charge of catalytic cracking for Shell Oil Company at its Montreal, Canada, plant.

**Jesse E. Hobson,** director of Stanford Research Institute since 1948, has submitted his resignation, effective March 31. His health and certain personal problems were listed as his reasons for leaving the organization.

Director of Armour Research Foundation before his appointment as head of the Stanford institute, Dr. Hobson has taught at Earlham College and Armour

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## What's Happening. . .

Institute of Technology, been an engineer with Westinghouse Corporation and served as director of the Department of Electrical Engineering at Illinois Institute of Technology.

During 1943-44 he was consultant to the Army Engineers' Manhattan district and in 1945, was chairman of the Mexican-American Conference on Industrial Research. Under the Mutual Security Agency, he participated in a series of industrial research activities in Europe in 1951-52.

**Vladimir A. Kalichevsky,** consulting chemical engineer for Magnolia Petroleum Company at Beaumont, Texas, has received the 1955 Southwest Award of the American Chemical Society.

**H. Harold Bible,** formerly assistant manager of manufacturing for Lion Oil Company, has been promoted to manager of manufacturing. The company is a division of Monsanto Chemical Company.

Also receiving new appointments in the Manufacturing department are **John A. Sherred** and **Frank L. Emert.** Their new assignments follow the creation of Development and Engineering sections.

Sherred, who had been director of research development for Monsanto's Plastics division in St. Louis, will be transferred to Lion Oil as director of development. Emert, who was assistant manager of Lion's El Dorado, Ark., refinery, is being promoted to director of engineering.

Bible, with the Lion organization since 1942, has held posts as technical assistant to the vice president of manufacturing, technical assistant to the president and assistant manager of manufacturing.

Holder of a master's degree in chemistry from England's Oxford University, Sherred joined Monsanto in 1947, after several years with the Shell Group. Emert has been with Lion since 1940, and seen service at both the refinery and the company's El Dorado chemical plant.

**James E. Lewis,** veteran California oilman and former Sunset Oil Company president, has been elected executive vice president and general manager of Independent Refiners Association of California, to succeed the late **Donald B. O'Neill.** Lewis has a broad background in the refining industry.

**Albert G. Noble,** retired U. S. Navy admiral, has been elected a vice president of Vitro Corporation of America, parent company of Refinery Engineering Company.

**L. F. Dowding,** assistant director of Jefferson Chemical Company's Austin, Texas, laboratories, has been promoted to assistant manager of the company's Manufacturing division, headquartered in Houston. With The Texas Company since 1939, he was transferred to the affiliated Jefferson company as a senior engineer in 1949. He was first assigned to Jefferson's Engineering department in New York, where he had served Texaco in a similar capacity.

**C. E. Davis,** Shell Oil Company vice president in charge of refining, has retired after 38 years with the company. He will become a petroleum consultant and serve part time as general secretary of the Fifth World Petroleum Congress, to be held in the U. S. in 1959.

**M. V. C. Sastri,** Indian scientist in the U. S. for a year's study under an exchange arrangement sponsored by the State Department's International Cooperation Administration, will spend three months in fundamental catalytic research at the laboratories of Houdry Process Corporation in Linwood, Pa.

Sastri

Dr. Sastri has been a member of the faculty of the Indian Institute of Technology at Kharagpur, near Calcutta, since its founding in 1951. Prior to World War II he was a research chemist with the Burma Oil Company at Rangoon, and directed the adsorption laboratory of the Indian Institute of Science at Bangalore, from 1945 to 1951.

He is the author of many papers on adsorption published in this country by the ACS. In 1951, he was chief Indian guest of the ACS at the 12th International Congress of Pure and Applied Chemistry in New York.

**A. C. Rall** and **J. F. Tim, Jr.,** have been appointed coordinators on the staff of Gulf Oil Corporation's senior vice president for financial affairs. They will assist **W. L. Taylor,** the vice president, in forming and coordinating the corporation's policies, plans and programs in its international activities.

**Aaron Wachter,** with Shell Development Company in Emeryville, Calif., has been given the 1955 Outstanding Service Award of Western Region, National Association of Corrosion Engineers. Dr. Wachter is immediate past president of NACE and has been long active in the association in administrative and technical capacities.

**Odom Fanning** has been appointed manager of information services for Midwest Research Institute. For the past two years, he has been in charge of the publication services at Georgia Institute of Technology's engineering-experiment station and editor of the station's magazine, *The Research Engineer.*

He was a reporter for *The Atlanta Journal,* 1940-43. During World War II he served in the Marine Corps, as a combat correspondent in the Pacific Theatre. For four years he was science reporter for *The Atlanta Journal,* and from 1949 to 1953 he directed a scientific-information program for the U. S. Public Health Service.

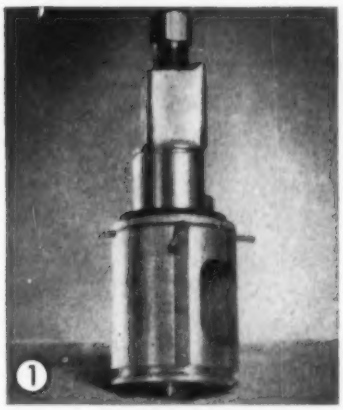
**Frank M. Dawson,** manager of The Texas Company's Purchasing department since 1954, has been elected vice president in charge of the Purchasing and Distribution department. He will be succeeded by **Howard S. McCray,** who was operating manager of the Refining department.

Dawson joined Texaco as a chemist at the Port Arthur, Texas, refinery in 1928, and later served there as assistant foreman and assistant superintendent of manufacturing. In 1939, he was transferred to New York as assistant to the vice president in charge of the Refining department, and in 1940 he became assistant superintendent of the company's Lawrence, Ill., refinery.

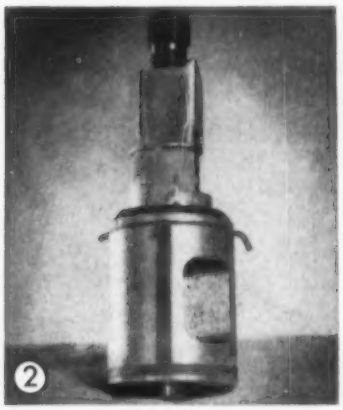
From 1942 to 1945 he was refining manager of an associated company in Argen-

# *SEE HOW *Controlled*
## PRESSURIZED LUBRICATION
GUARANTEES LOWEST COST SERVICE FROM

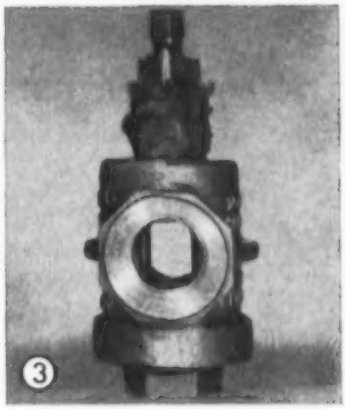
# HOMESTEAD *lubricated* PLUG VALVES



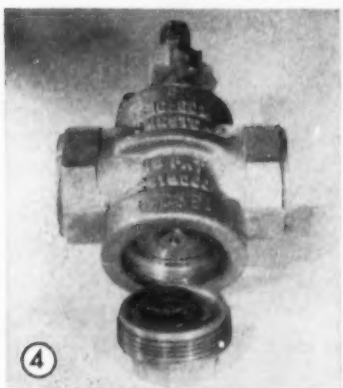

This plug was removed from a Homestead Valve just after starting lubrication, and before all sealing areas were filled with lubricant. Note that pressurized lubricant continues to extrude through feeder holes. Momentary downward movement of plug at start of each lubrication, gives assurance that plug is always free to turn.



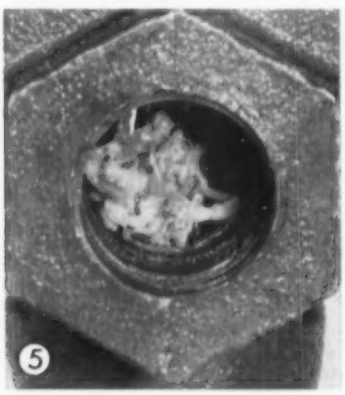

The plug was again withdrawn from the valve body just after a ring of lubricant around the stem indicated that the lubricant system was full. Note that all lubricant grooves are filled. The entire plug surface is coated with lubricant. Lubricant is well packed in the stem sealing area above the plug.




Now valve has been purposely over-lubricated as indicated by excess lubricant around stem. Note that with *controlled* pressurized lubrication there is no extrusion or seepage of lubricant into valve port opening. This means no waste, no contamination of line fluids, no clogging of low pressure lines with lubricant, or fouling of meters, orifices, etc.




Also, in the Homestead Valve with *controlled* lubrication, you will note that even though the valve has been over-lubricated, lubricant comes only to the bottom edge of the plug, and is not wasted by discharging in quantity into the bottom chamber.




Now, see for yourself the risk involved when a valve which does *not* have Homestead's *controlled* Pressurized Lubrication, is over-lubricated. Note lubricant has been forced into the port opening. It can contaminate line fluids, foul meters or orifices, or even block low pressure lines!

* Unretouched photos.

These are but a few of the many advantages of Homestead's controlled . pressurized lubrication that guarantee lowest cost valve service.

Reference Book 39-5 has the full story—twenty-eight pages of engineering facts, sizes, types, dimensions, etc. Ask for your copy today. There is no obligation.

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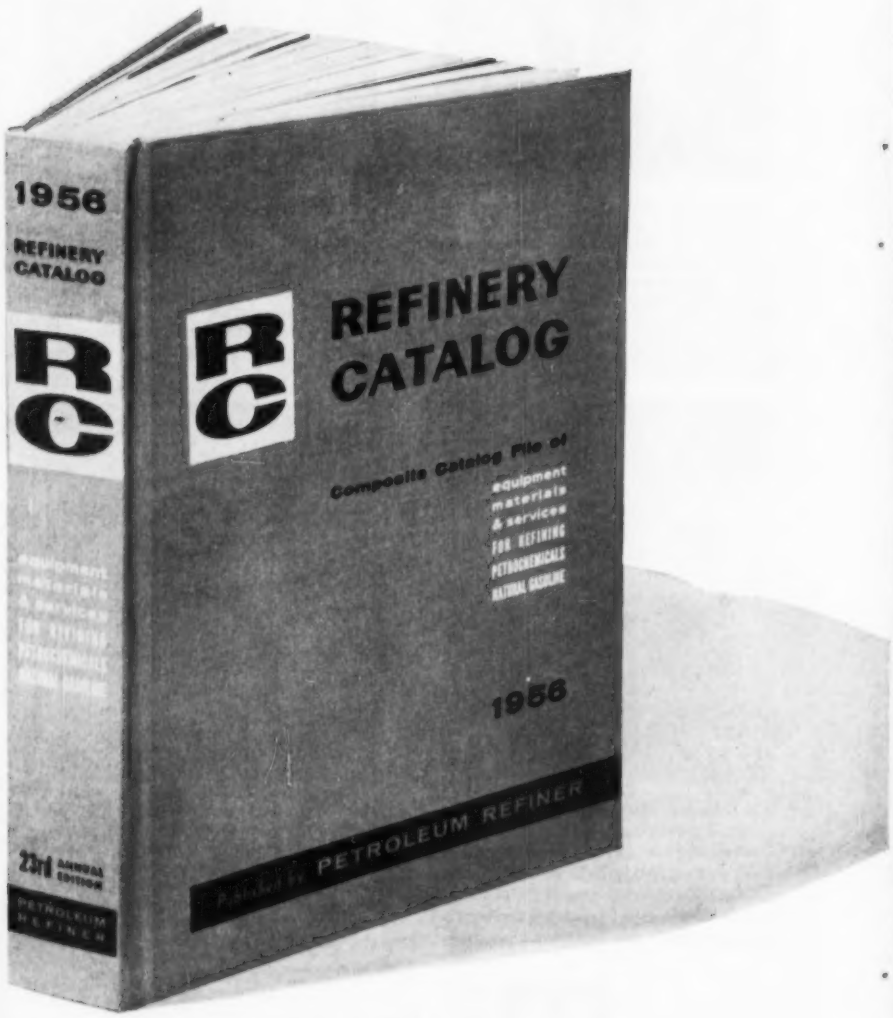




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# ..... on its way to YOU

## The 23rd (1956) REFINERY CATALOG

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A glance at the illustration on the opposite page will show you the new front cover "dress" . . . which will enable you to recognize this useful volume at a glance.

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Even though your old friend has a new appearance, it is more valuable and useful this year than ever before. Here's part of what you'll find in it:

- ★ Complete or condensed catalogs of more than 270 manufacturers, service companies, and suppliers serving the industry.
- ★ Authoritative, up-to-date specifications and data.
- ★ Local sources of supply.
- ★ Convenient alphabetical index of manufacturers and a classified index of equipment, materials and services.

If you are not among the thousands of men in buying power jobs whose names have been submitted to us by their companies to receive a personal copy of the current REFINERY CATALOG, tell your immediate supervisor that you'd like to be included. In the meantime, you're sure to find a copy you can use somewhere nearby in your department. Remember to look for the large "RC" on the cover.

# The REFINERY CATALOG

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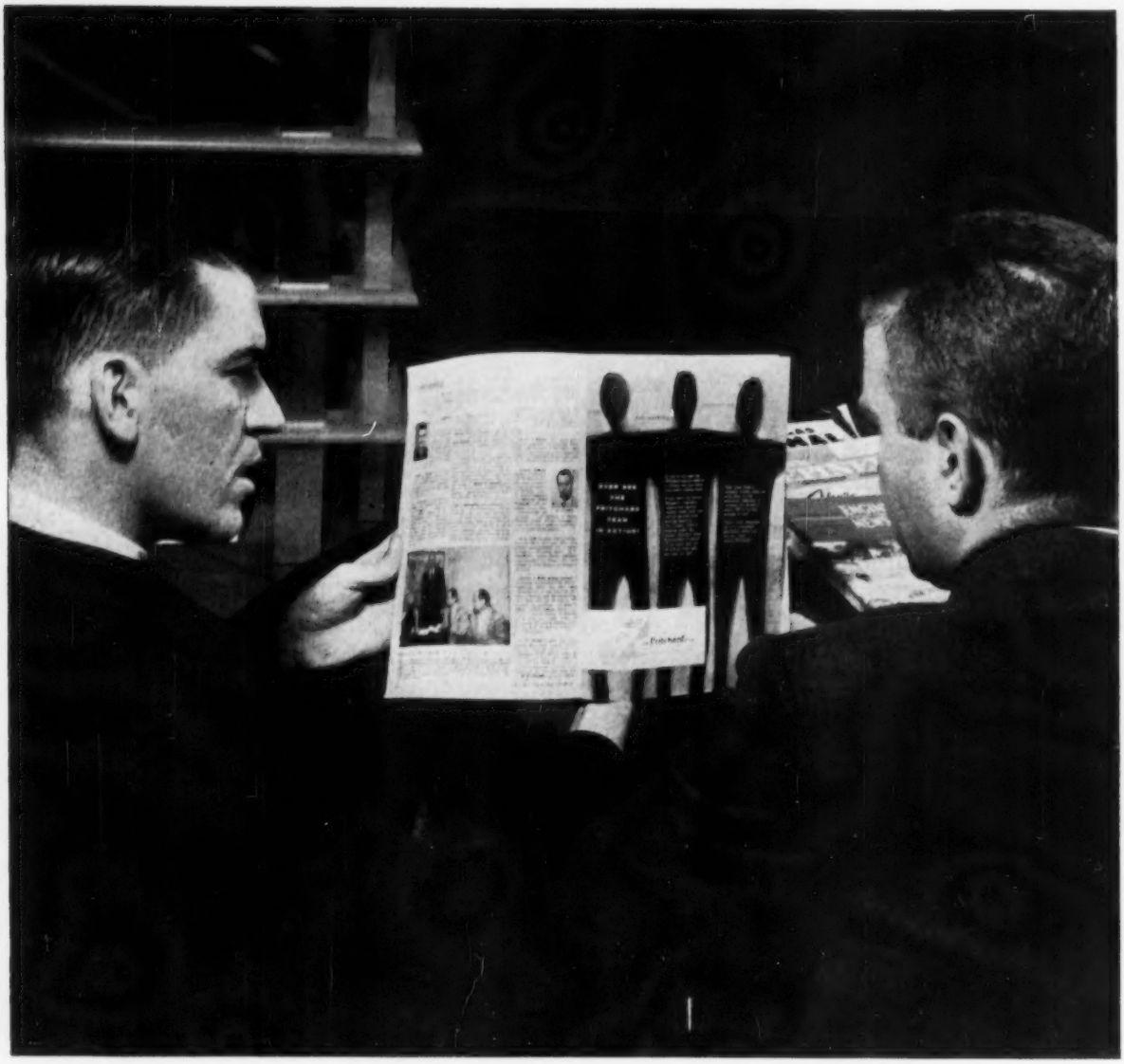

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"What makes you ask?"

"I was just looking at this Pritchard ad, and it says, 'Ever See the Pritchard Team in Action?' and then it goes on to say, 'designers, engineers, construction superintendents work *with* your staff all the way from drawing board to on stream.'

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"You bet I am, and you will be too, when you see the Pritchard team in action."

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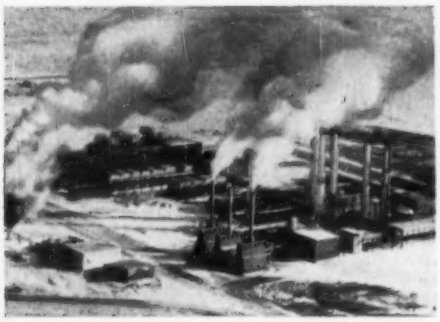

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This interesting booklet describes and illustrates the Signal Oil & Gas Company's natural gasoline, $H_2S$ removal and sulphur recovery plant at Tioga, N. D. Write for your complimentary copy on your company letterhead.

*INDUSTRY'S PARTNER FOR PROGRESS*

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ENGINEERS • CONSTRUCTORS
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Kansas City 12, Mo.

SERVING THE GAS, POWER, PETROLEUM AND CHEMICAL INDUSTRIES
BOSTON, CHICAGO, BUFFALO, HOUSTON, NEW YORK, PITTSBURGH


## What's Happening. . .

tina. In 1945, he was named superintendent of Texaco's Lawrenceville refinery and nine years later, took charge of the Purchasing department.

With the company since 1926, McCray also started at the Port Arthur works. After six years there, he was made assistant superintendent of the company's Port Neches works, and in 1940 he was named superintendent of the Texaco refinery at Sunburst, Mont. He also served as superintendent of the refineries at Amarillo, Texas, and Lawrence and Lockport, Ill., before he was transferred to New York, to head operations in the Refining department.

**Bernard C. Barton** has been named director of research and development for Texas-U. S. Chemical Company. He will head the company's research and development work on the production of synthetic rubbers and the expanded use of petrochemicals. He will headquarter in New York.

Barton

Dr. Barton formerly was head of the Rubber Applications and Synthetic Rubber Research department of United States Rubber Company's general laboratories. United States Rubber, with The Texas Company, owns Texas-U. S. Chemicals.

He joined the staff of the general laboratories in 1939. Since then Dr. Barton's primary interests have been in the development of synthetic rubbers and in the basic study of vulcanization and aging of elastomers.

**Don W. Woods,** director and general counsel of General Petroleum Corporation, has retired after nearly 40 years in the West Coast petroleum industry. Woods, who was named director and general counsel for the corporation in 1946, joined General in 1916. He became secretary of the company in 1932.

**Oliver E. Beutel,** traffic manager of The Dow Chemical Company's Texas division at Freeport since 1943, has been advanced to a newly-created position of manager of distribution and traffic with company-wide responsibilities. In his new capacity, Beutel will coordinate the distribution of chemicals from all the company's divisions.

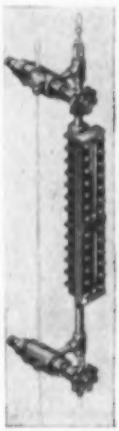
Beutel, who will be stationed at Midland, has been with the company 20 years. During this period he served successively as a time-study engineer, assistant superintendent of the Service department and as assistant to the superintendent of shops and services at Midland. He was in charge of the Service department and traffic at Freeport for three years before becoming division traffic manager.

**William A. Burns,** with The American Oil Company at its Savannah, Ga., refinery since 1952, has been promoted to plant manager. He succeeds **Edward R. Grey,** who has been in charge of the Savannah refinery since 1948.

Grey will become plant manager of the company's refinery in Baltimore, taking the place of **William W. Hulin** who will


**How to Solve Problems of ACCURATE GAGING**
*of levels and pressures when liquids are*
**COLD and SLOW or HOT and FAST**

Whether you handle liquids whose flow is "slow as cold molasses," or which boil and surge so they're hard to gage, Jerguson can solve your problems of accurate liquid level and pressure gaging.



***Jerguson Heated or Cooled Gages***

Specially designed to carry a circulating medium . . . heated to speed up the flow of slow, cold liquids . . . cooled to slow down boiling or surging liquids. Give you accurate liquid level readings, without tracing.

***Jerguson Heated or Cooled Valves for Pressure Gages***

Jacketed design with built-in tracing. Cold, heavy liquids flow so you get accurate pressure readings. Special design reduces threaded connections; combines unions, nipples, etc. in one compact unit. Ideal for cold services, waxes and other heavy materials.

Jerguson Gages and Valves now available with Electric Heating. Ask for special details.

*Write for Data Units: #237 on Heat-Cooled Gages; #252 on Valves for Pressure Gages, etc.*

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*Gages and Valves for the Observation of Liquids and Levels*
**JERGUSON GAGE & VALVE COMPANY**
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*Offices in Major Cities*
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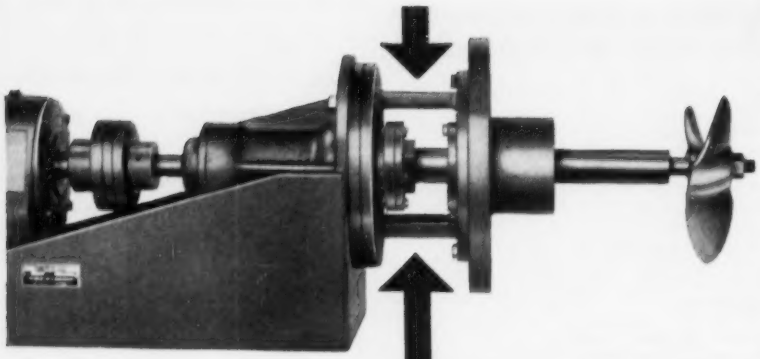
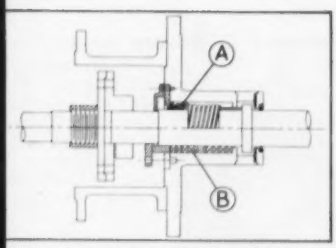
Pétrole Service, Paris, France



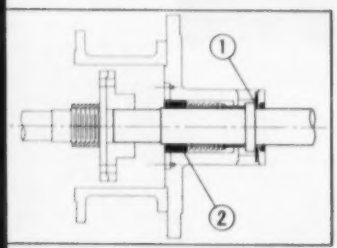
# THIS MIXER'S A MAINTENANCE MISER

Nettco Side Drive Mixers are now available with mechanical shaft seals of unsurpassed lasting qualities. The Nettco design permits seal inspection or service under full pressure . . . without draining storage tanks or other time-consuming preparations. The seal service operation is simple, quick, inexpensive. If repair parts are not available, the complete assembly can be replaced by a conventional stuffing box. *Only Nettco offers this feature!*

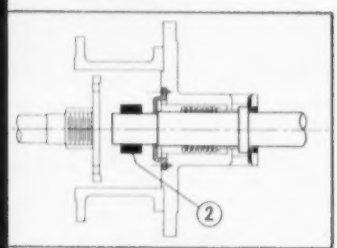
Nettco Side Drive Mixers with the "maintenance-miser" seal are available in ⅓ to 30 HP sizes . . . in many arrangements and alloys to suit specific job requirements. Next time check Nettco — for prices and recommendations. New England Tank & Tower Co., 81 Tileston Street, Everett 49, Massachusetts.




Seal arrangement showing interchangeability of mechanical seal (A) and conventional stuffing box (B).




Mechanical seal isolated from tank pressure by secondary shut-off collar 1, with seal parts 2, exposed for inspection.




Seal in open position with split flange coupling removed for repair or replacement of seal parts 2.

Send for new Side Drive Bulletin #532.

NETTCO
ENGINEERED AGITATION


## What's Happening. . .

retire. Asphalt is the principal product of both refineries.

Burns joined the company at Texas City, Texas, in 1943. Before taking a supervisory position at Savannah in 1952, he served as chemical engineer and general foreman in the chemical plant of the company's Texas City subsidiary.

Grey started with American Oil as chief engineer of the Savannah refinery in 1941. He served as assistant superintendent from 1945 until 1948, when he was placed in charge of the refinery.

Assisting Burns in directing the Savannah operation will be **Alphonse J. Schano,** mechanical superintendent, and **Ernest T. Chisholm,** operating superintendent.

**Henry Groppe,** until recently assistant director of development for Monsanto Chemical Company's Plastics division in Texas City, Texas, has joined **Joseph R. Mares** in his practice as an industrial-chemical consultant in Houston.

Groppe

Groppe, who also has handled economic-evaluation and process-design work for Monsanto, has been associated with The Dow Chemical Company at Midland, Mich., engaged in process engineering in a Texas Company refinery, and done refinery-operation and process-engineering work for Arabian American Oil Company. In Saudi, Arabia, he was assistant to Arabian American's manager of refining.

**Robert S. Aries** has been elected a fellow of the New York Academy of Science, in recognition of his scientific achievements. Dr. Aries is president of R. S. Aries & Associates, a New York chemical-consulting organization, and a part-time member of the graduate faculty at the Polytechnic Institute of Brooklyn. He holds 18 U. S. and foreign patents.

**Arthur M. Sherwood,** legal counsel for Socony Mobil Oil Company in New York, has been appointed assistant secretary.

**J. Fletcher Chace** has been elected a vice president and director of Mitsubishi Oil Company, Ltd., with headquarters in Tokyo. The Japanese refining company is an affiliate of Tide Water Associated Oil Company. Chace replaces **Irving E. Chapman** as a Mitsubishi Oil vice president. Chapman, who is returning to the U. S. to rejoin the Tide Water organization, continues at a Mitsubishi director. Chace, who has been on foreign assignments for major oil companies since 1946, joined Tide Water two years ago.

**M. S. Umbenhauer** has been appointed manager of power plant design for The Fluor Corporation, Ltd. Umbenhauer brings to Fluor more than 25 years engineering and administrative experience in designing and building power plants.

Before joining Fluor, Umbenhauer was with Energy Control Company, Inc., and chief mechanical engineer for Burns and Roe, Inc., both in New York. Other posts include general manager and chief en-



For more data on advertised products, use Readers' Service Cards, last page.

One man in this midget fire truck puts out the fire. Rockwood equipment makes it possible!

# "Mighty Mite" puts out fire in 45 seconds

"Mighty Mite" is a swift fire fighter!

It was just a test, but the fire was real. Fuel in a pit under the tank car was set on fire. Fuel poured on top of the car from pipes was also ignited. The blaze was given a minute's start.

"Mighty Mite", loaded with Rockwood fire fighting equipment, went into action. The blaze was choked off in 45 seconds by Rockwood WaterFOG from Rockwood's Remote Manual Control Turret!

Rockwood equipment makes the small truck a big fire fighter. The Turret Nozzle does many jobs—discharges solid water stream, WaterFOG, FogFOAM, solid FOAM stream, "Wet" solid water stream, and "Wet" WaterFOG!

For complete details on this powerful Rockwood equipment send coupon below.

## ROCKWOOD SPRINKLER COMPANY

*Engineers Water . . . to Cut Fire Losses*

***Distributors in all principal cities***

"Mighty Mite's" equipment includes: 4 stage centrifugal pump, 200-gallon booster tank, Rockwood Dual Suction Proportioning System for FOAM and "Wet", Rockwood Remote Manual Control Turret controlled from within the cab, Rockwood Ground Sweep Nozzles, Rockwood Remote Control Ball Valves, 2 hose reels with 200 feet of high pressure hose with new Rockwood High Pressure Handline Nozzle on each reel.

ROCKWOOD SPRINKLER COMPANY
Portable Fire Protection Division
1088 Harlow Street
Worcester 5, Mass.

Please send me your illustrated booklet on Rockwood fire fighting products.

*Name* .....

*Title* .....

*Company* .....

*Street* ..... *City* .....

*Zone* ..... *State* .....



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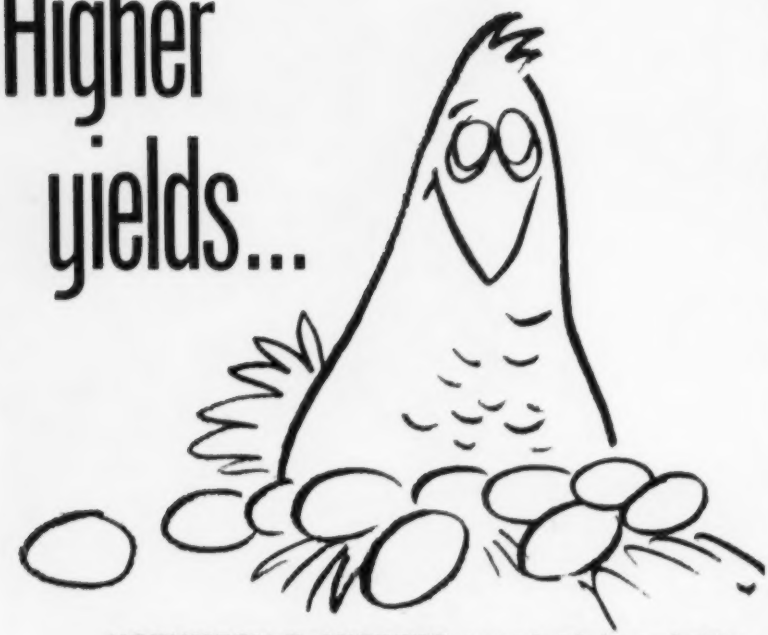
# Higher yields...



**YORKMESH DeMISTERS permit higher yields—**

In refinery vacuum towers:

Increased yield of gas oil by cutting deeper into the bottoms.

Increased yield of liquid products in the cat cracker due to decreased carbon and asphaltic materials in the gas oil.

Increased yield of gasoline due to high catalyst activity, which is maintained since Yorkmesh DeMisters remove vanadium and nickel compounds which are otherwise carried over by entrainment into the gas oil product.

---

Yorkmesh DeMisters give increased yields of liquid products from wet gas.

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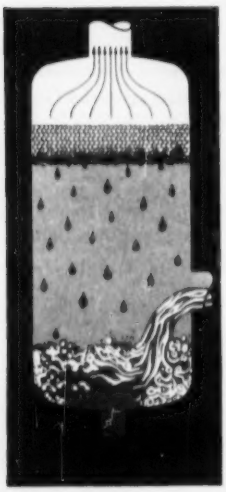
In evaporators, Yorkmesh DeMisters give increased yield by preventing loss of product by entrainment to the condenser.

---

*When installed in new or existing process vessels, these wire mesh entrainment separators improve process efficiency, increase throughput capacity, improve overhead quality, reduce product contamination, or avoid air pollution.*



**CLEAN Separation**

As vapors or gas flow through the wire mesh, the entrained liquid impinges on the wire surfaces and is coalesced into large drops which run off by gravity flow. The clean vapor passes overhead.

Yorkmesh DeMisters provide clean separation between liquid and vapor in:

Vacuum Towers • Distillation Equipment
Gas Absorbers • Scrubbers • Evaporators
Knock-Out Drums • Steam Drums

**YORK**

**OTTO H. YORK CO. INC.**
6 CENTRAL AVENUE, WEST ORANGE, N. J.


## What's Happening. . .

gineer of Armstrong Engineering Company, New York; power and maintenance superintendent, Lion Chemical Corporation, El Dorado, Ark., and an incremental studies engineer for American Gas and Electric Company.

**Orin Atkins,** since 1950 a member of the legal staff of Ashland Oil & Refining Company, has been named executive assistant to the company's management. Atkins joined the company's legal forces following his graduation from law school at the University of Virginia.

During World War II, Atkins saw service with the Army in Europe where he was twice wounded.

Atkins

**Louis R. Noffsinger** has joined the Optics and Metrology division of the Bureau of Standards.

**Bernard M. Sturgis,** assistant director of the Petroleum laboratory of E. I. Du Pont de Nemours and Company, Inc., has been picked to receive the SAE Horning Memorial Award in Detroit.

He is being honored for authorship of a technical paper entitled "Some Concepts of Knock and Anti-Knock Action" which he presented at the 1954 SAE National West Coast meeting. This paper was judged as the best new contribution to existing knowledge in mutual fuel and engine adaptation presented at a SAE meeting during 1954.

Dr. Sturgis joined Du Pont in 1936 and was assigned to research on rubber chemicals. He became group leader in 1942 and in 1946 he was promoted to head of the Petroleum Chemicals division in Jackson laboratory. In 1951 he moved to the Du Pont Petroleum laboratory as head of the Combustion and Scavenging Research division, and in 1953 was appointed assistant director of the Du Pont Petroleum laboratory.

**Lucien O. Crockett,** general manager of Gulf Oil Corporation's Chemical department, has been elevated to vice president. He will continue to direct the company's chemical activities.

**Lawrence M. Griffin** is now with Procon, Inc. Formerly with Southwestern Engineering Company, he will report to affiliated Procon (Great Britain), Ltd., for work in Europe. He is a mechanical engineer and sold refinery equipment for several years in the western U. S.

**James P. O'Donnell,** New York and Beaumont, Texas, consulting engineer, has made three promotions in his staff. **John J. Lanigan,** was advanced to senior associate engineer while retaining his post of chief engineer. Promoted to associate engineers were **George J. Feinman** and **Edward G. Fitzgerald.** The three posts are newly-created executive positions with the firm.

**Barrett B. Russell,** of E. I. DuPont de Nemours and Company in Tulsa, will serve as 1956 vice chairman for the School Program of the Kansas-Oklahoma District of



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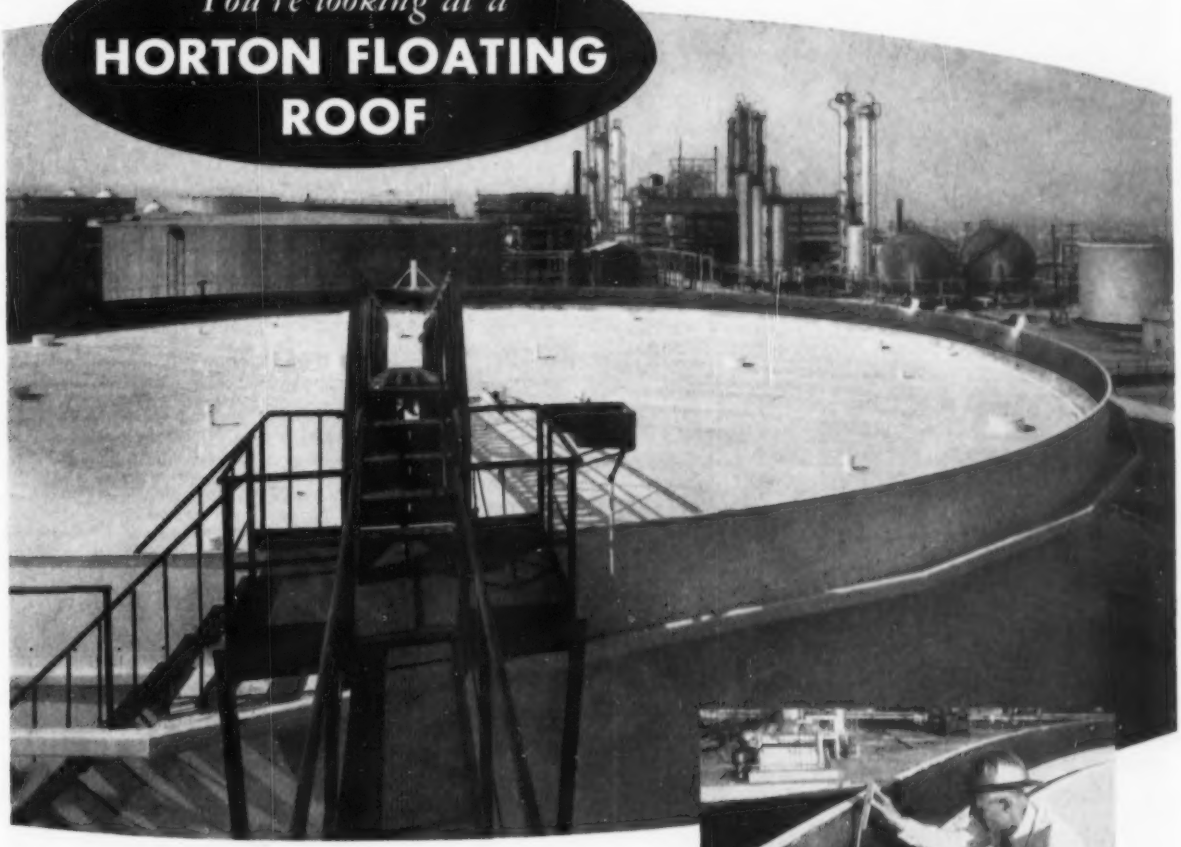
*You're looking at a*

# HORTON FLOATING ROOF



*. . . and the reason*

## *for its* EFFICIENCY. . . . . .

Floating directly on the surface, the entire bottom of a Horton® Floating Roof is normally in contact with the liquid in the tank. There is no air-vapor mixture above the liquid to be vented and lost. The space between the rim of the roof and the tank shell is efficiently closed by a Horton Seal to prevent vapor from escaping.

Horton Floating Roofs are built in three types—Double-Deck, Pontoon and Pan. Write our nearest office for further information.

The man in the view above is holding a carpenter's rule against the side of the tank to demonstrate the snug fit of the Horton Seal. A continuous sealing ring with vertical flexures every 22 inches allows the ring to conform perfectly to the tank shell.

CBI

**Chicago Bridge & Iron Company**

Atlanta • Birmingham • Boston • Chicago • Cleveland • Detroit • Houston
Los Angeles • New York • Philadelphia • Pittsburgh • Salt Lake City
San Francisco • Seattle • Tulsa
*Plants in* BIRMINGHAM, CHICAGO, SALT LAKE CITY and GREENVILLE, PA.



For more data on advertised products, use Readers' Service Cards, last page.

## What's Happening. . .

the Oil Industry Information Committee. Announcement of the appointment was made by **Robert A. Douglass**, of the Ethyl Corporation, OIIC district chairman. Russell succeeds **G. F. Kershner**, Continental Oil Company, formerly of Ponca City, Okla., who was transferred to Houston, Texas.

Russell, who is assistant regional manager for DuPont's Petroleum Chemicals division, formerly was in Wilmington, Dela., as technical assistant to the sales manager. Prior to that he was with the firm's Chicago office. While in Chicago, he was active in Oil Industry Information Committee work, serving as school program vice chairman for the state.

Clark

Maass

**William C. Clark,** now superintendent of the Refining and Oil Movement division of Esso Standard Oil Company's Baton Rouge, La., refinery, has resigned to join the affiliated Standard-Vacuum Oil Company. He will be manager of the Refining department of Standard-Vacuum Petroleum Mij., Stanvac's refining subsidiary in Indonesia.

**Randal O. Maass**, presently manager of the Manufacturing department of Standard-Vacuum Petroleum, has been named manager of a newly-created Supply, Transportation and Service division. The division was set up to separate supporting service's for overall company services in Indonesia.

Maass began his industry career with General Petroleum Corporation in 1934, and in 1951 went to Indonesia as SVPM's assistant to the manager of the Manufacturing division. Three years later he was promoted to manager. Clark's 25 years in the industry includes, besides executive positions with Esso Standard, the superintendency of the Campana refinery of Esso Refinadora de Petroles in Argentina.

**J. F. Collins, Jr.,** has been named to manage a new Technical Service regional office set up by The Texas Company at Atlanta, Ga. He formerly was a technologist in the company's regional office at Houston.

With the company since 1929, Collins has served the Texaco organization at its Port Arthur, Texas, refinery and Technical Service division's offices in both Houston and New York. His assignments have centered on services to industrial customers.

**Robert L. Hershey,** assistant general manager of the Polychemical department of E. I. DuPont de Nemours and Company, has been moved up to general manager of the department. He succeeds **Emil D. Riese** who will retire.

**R. L. Hock** has been appointed manager of American Cyanamid Company's Frontier plant at New Orleans. Named as assistant plant manager was **J. I. Davidson.**

Hock joined Cyanamid in 1952 as assistant plant manager at Frontier. Prior to that he spent 28 years with U. S. Industrial Chemicals, Inc., as assistant manager and manager of that company's New Orleans plant, and as manager of its plant at Baltimore.

Davidson, who has been with Cyanamid since 1942, serving first with the affiliated Chemical Construction Corporation. He has been assistant manager of the Power department at the Bound Brook, N. J., plant, as chief power engineer at the plant in Willow Island, W. Va., and as consulting engineer at Bound Brook.

Before his transfer to New Orleans, Davidson was a consultant on services at the Toronto, Ont., office of Chemical Construction Corporation and at Cyanamid's Savannah, Ga., plant.

**George E. Kopetz** has been elected vice president in charge of production for Blaw-Knox Company. At the same time, four veteran employes were promoted to newly-created posts of vice presidents in the company's Chemical Plants division.

**Arne O. Olson** was named vice president in charge of engineering; **Keator McCubbin**, vice president and manager of the Chemical Plants division's Midwest headquarters in Chicago; **Charles F. Hauck**, vice president for sales; and **Edward S. Wright**, vice president in charge of construction.

Kopetz joined Blaw-Knox Company in 1939, following several years as an engineer in the chemical industry. He aided in the organization of the company's Chemical Plants division, serving as chief engineer and contract manager and, later, as vice president and assistant general manager.

Early in World War II, he coordinated


Castings for the Oil Industry

SERVICE FOUNDRY

a division of Avondale Marine Ways, Inc.

Service Foundry is one of the few foundries in the southland with facilities for large capacity work . . . and "SERVICE" is a past master at serving the foundry needs of the Oil Industry. Your most exacting requirements can and will be met on castings of all types (iron, steel and non-ferrous)—gear cutting and machine work.

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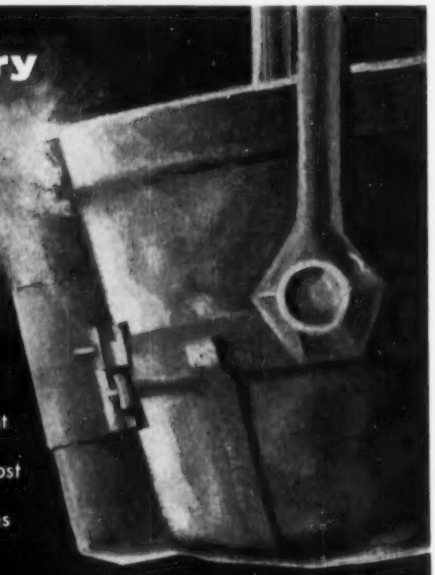

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## . . . there's enough difference to make ALL the difference

This is just one inspection of extrusion dies through which a cast billet heated to a rigidly controlled temperature is hot extruded into a "tube shell" . . . from which Scovill Heat Exchanger Tube is subsequently cold-drawn.

One of the most highly skilled and critical jobs in the process is that of finishing and maintaining these dies. The smooth, clean surfaces of resulting shells are essential assurance of highest quality in finished tubes.

It is needless to tell Scovill customers that, while *correct alloy selection* is important to efficient exchanger operation, of equal importance is the *uniformity and soundness of tubes* themselves. Scovill Technical Service and tube production methods, considered by many the very best in the industry, can give you complete assurance on both these essential counts.

Scovill Heat Exchanger Tube is available in a comprehensive range of standard alloys (listed below).

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99 Mill Street, Waterbury 20, Connecticut. Phone Plaza 4-1171.

**SCOVILL** **HEAT EXCHANGER TUBE**

Phosphorized Admiralty • Admiralty • Arsenical Admiralty • Muntz Metal • Naval Brass • Red Brass, 85% • Deoxidized Copper
Arsenical Copper • Copper Nickel, 10% & 20% • Cupro Nickel, 30% • Aluminum Brass • Aluminum Bronze, 5% • Duplex Tube

19C98



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## What's Happening. . .

the division's work in designing plants for the nation's synthetic rubber program. In recent years, in addition to his administrative duties, he has been active in Blaw-Knox's nuclear-energy activities.

With Blaw-Knox since 1930, Olson has been engaged particularly in synthetic resins. In his new capacity, he will direct division engineering and procurement.

McCubbin joined Blaw-Knox in 1947, after working ten years as a chemical engineer with the A. E. Staley Manufacturing Company in Decatur, Ill.

Hauck for many years was a chemical engineer with Hall Laboratories, Inc., and Atlas Powder Company. In his new post he will direct divisional sales activity and coordinate the division's nine process departments.

Construction activities of the Chemical Plants division will be headed by Mr. Wright, who joined Blaw-Knox in 1942.

**Thomas S. Lennox** has been appointed manager of the Trenton, Mich., refinery of Socony Mobil Oil Company, Inc., succeeding **Samuel G. Keller**, who will retire.

Lennox, now assistant manager of the refinery, joined Socony Mobil in 1930 as manager of the Grease and Compounding department of the Trenton plant.

Born in Scotland, Mr. Lennox received a degree in chemical engineering from the Royal Technical College. He came to the United States in 1921.

Keller's service with Socony Mobil dates back to 1922, when he went to work for White Star Refining Company at Wood River, Ill. He has been manager of the Trenton refinery since 1946.

**Thomas M. Dailey, Jr.,** has joined Tide Water Associated Oil Company as manager of the Economics department. For the past nine years Dailey has been petroleum economist for Humble Oil & Refining Company in Houston. Previously he had been with Woodley Petroleum Company, also in Houston. During World War II he served in Washington, first with the Petroleum Administration for War and later with the Army-Navy Petroleum Board's Planning division.

Dailey

**Ross W. Cummings,** former newsman, has been named director of information and public relations for Kerr-McGee Oil Industries, Inc. In this capacity, he will handle public relations as well as supervise publications and employe communications for the Kermac organization.

Formerly managing editor of the Holdenville Daily News, Cummings earlier had worked as a member of the advertising staff of *The Wewoka* (Okla.) *Times* and as news broadcaster and announcer for radio station WBBZ in Ponca City.

**Ralph A. Cuthbertson** has been elected treasurer of Cities Service Oil Company (Pa.). Cuthbertson, previously secretary of the company, succeeds **Walter W. Martin**, who is retiring after 52 years of service with the company, the last 22 years as treasurer.

Cuthbertson has been with Cities Service for 35 years. He joined the company as a bookkeeper in Cleveland in 1920 and has been secretary of Cities Service Oil Company for the past 12 years.

He will be succeeded as secretary by **James W. Fry**, an employe of Cities Service since 1926 and office manager of the Philadelphia region since 1950.

Martin began his Cities Service career in 1903, as an accountant for Denver Gas and Electric Company, then a subsidiary of Cities Service. He served several Cities Service companies in Colorado, Texas, Ohio, Pennsylvania and other states before going to New York in 1933 as treasurer of Cities Service Oil Company (Pa.).

**Graham B. Knight** has joined **Joseph R. Minevitch** in his consulting-engineering practice in Boston. Knight has been connected with E. B. Badger & Sons Company and its successor, Badger Process division, Stone and Webster Engineering Corporation. His most recent connection was with Badger Manufacturing Company.

A registered professional engineer in Massachusetts, New York and Texas, Knight has had several years experience in process engineering and in the design and operation of refinery units and chemical plants.

**J. W. Leonard** will serve as board chairman and chairman of the executive committee of Leonard Refineries, Inc., and **Reid Brazell** will be the company's president and chief executive officer. Their elections follow consummation of the merger into Leonard Refineries of Mid-West Refineries, Inc., and Roosevelt Oil & Refining Corporation. Also acquired in the merger was Leonard Pipe Line Company.

**W. M. Murray,** vice president of Deep Rock Oil Company, has been elected president of the National Lubricating Grease Institute. A veteran of 34 years in the petroleum industry, he has been active in institute affairs for several years.

**J. W. Lane**, manager of Socony Mobil Oil Company's Automotive division, was made vice president, and **A. J. Daniel**, president of Battenfield Grease and Oil Corporation in Kansas City, was named treasurer.

**Robert H. Aitken,** a veteran of almost 30 years with The Texas Company, has been named manager of a newly-established Refining division. Another new unit in the Texaco organization is the Supply and Distribution division, to be headed by **W. Henry Ryer**, with previous service in Puerto Rico and the Canal Zone and formerly in charge of foreign sales at the company's New York office. **Landon B. Derby**, who has been with Texaco and its affiliates 27 years, was appointed to succeed Ryer in the New York position.

**A. M. Zarem** has resigned as assistant director and manager of the Southern California division of Stanford Research Institute, to devote his full time to private consulting. Dr. Zarem, who intends to open a Los Angeles office, had been with the institute since 1948. He has long been identified with electronics and physical science research on the West Coast.

**R. K. Gould** is the newly-appointed editor of *Lubrication Engineering*, the journal of the American Society of Lubricating Engineers. Dr. Gould, with the Texas Company since 1941, also serves as editor of that company's magazine, *Lubrication*.

SEND FOR PSC
BUBBLE CAP BULLETIN 22
300 Styles Furnished Without Die Cost
This standard reference on bubble caps and risers contains complete specification information for hundreds of variations. Also many drawings for use in determining methods of tray assembly. With dies on hand for all listed styles, PSC can save you substantial die costs as well as design and delivery time. Furnished in any drawing type of metal, to meet your coking or corrosion problems. Assemblies will also be produced to your specifications.
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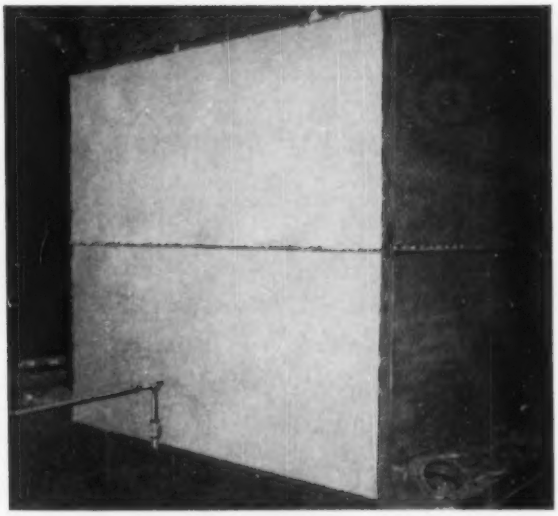
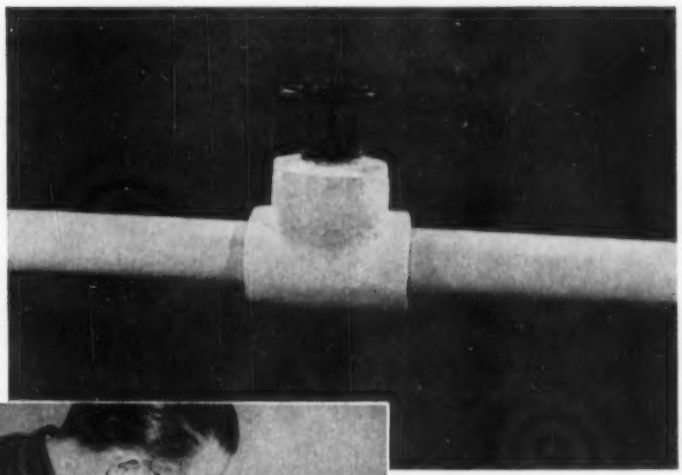
THE PRESSED STEEL CO. • Wilkes-Barre, Pa.



Large, flat areas are quickly insulated with B-H Super Powerhouse Cement.

# BALDWIN-HILL *Super* POWERHOUSE CEMENT.....

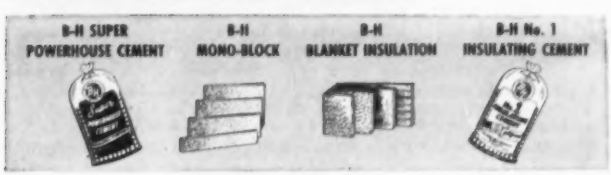
# NOW IS.... WHITE



B-H Super Powerhouse Cement trowels easily and sets quickly to form a smooth, white, glazed surface to conform to surrounding pipe covering.

Where adjacent pipe covering is painted, B-H Super Powerhouse Cement readily takes application of either water-base or oil-base paints.

**Made from the NEW Baldwin-Hill Spun Mineral Wool fibers, Super Powerhouse Cement dries out *white* to give you a better, more pleasing finish coat. And remember, it requires only one-coat application because it *insulates* as it *finishes.***




**BALDWIN-HILL COMPANY**

**701 Breunig Ave. Trenton 2, N. J.**

**Kalamazoo, Mich. Huntington, Ind. Temple, Texas**

# What Suppliers Are Doing . . .

Griffiths Brown Bierck Ford McCauley Habach

**Wayne Griffiths** has been appointed manager of the new district office **Hudson-Rush Company** has opened in Amarillo, Texas. Griffiths, who has been located in Amarillo several years, as a sales engineer for the concern, will be in charge of its sales operations in the Texas-Oklahoma Panhandle area.

**Chester M. Brown** has been named president of General Chemical division, **Allied Chemical & Dye Corporation. Mark M. Biddison**, who had headed that division since 1951, will continue with the company in an advisory capacity and handling special assignments. Brown began his career with the division as a production trainee at the East St. Louis, Ill., Works, in 1929.

**Richard C. Bierck** has been named as general sales manager for **Dean Brothers Pumps, Inc.**, in Indianapolis. Starting in the company's Engineering department 11 years ago, Bierck transferred to the Sales department in 1950, and rose to regional sales manager.

**Paul C. Ford** has been made chief engineer of **Wagner Electric Corporation's** Electric division in St. Louis, succeeding **C. P. Potter**, who retired after 46 years with the company. Ford joined the Warner organization in 1937 as a student engineer.

**John C. McCauley** has been appointed to the sales engineering staff of **Hammond Iron Works.** McCauley, with the metal fabricating industry 11 years, will make his headquarters in New York.

**George F. Habach** has been elected vice president in charge of engineering for **Worthington Corporation.** He will assume full administrative responsibility for the company's engineering activities, including research and development. Habach succeeds **Harry A. Felbush** who will continue on the technical staff as a consultant on special engineering problems. Felbush has been with the company more than 40 years.

Hassmann LaSusa Rose Horth Laramy Borel

**Harry F. Hassmann** has been appointed sales engineer for the affiliated **Otto H. York Company, Inc.,** and **York Process Corporation.** Prior to joining York, Hassmann was a process engineer with The Fluor Corporation.

**C. D. LaSusa**, formerly specialist in sales of **Armour and Company's** chemicals used by the petroleum industry, has been named manager of the Chemical division's newly established Southern Region. LaSusa joined Armour in Chicago as a chemical salesman in 1950.

**A. W. Rose** has been named vice president and general manager of the Petro-Mechanics Research division of **Borg-Warner Corporation.** Also a vice president of Borg-Warner. Rose has been with the company 24 years.

**John D. Horth** has been appointed assistant manager of the Compressor Sales department at De Laval Steam Turbine Company. Horth joined De Laval in 1947, and served in Chicago until 1949, when he was named district manager of the St. Louis office. In 1951 he transferred to the Compressor Sales department in Trenton, N. J.

**John B. Laramy** is the new assistant general sales manager of Worthington Corporation. Laramy joined Worthington in 1929. He was assigned to the company's Chicago office where he later became assistant district office manager. In 1951 he was appointed manager of the Marketing Research department.

**Frederick C. Borel, III**, has joined Arthur G. McKee & Company as sales engineer in the Industrial Engineering division. He previously had held a similar position with H. K. Ferguson & Company. For 16 years, Borel was associated with major construction activities throughout the U. S.

Keller Hancock Blair Cox Scales Salls

**Ernest A. Keller** has been named director of research for **Panellit, Inc.** A Swiss physicist, Keller came to the U. S. in 1950 as a technical executive to evaluate markets for Oolikon Machine Tool Works of Zurich. Later he joined Daystrom Electric Corporation, as physicist in charge of developing tape recorders and high-fidelity sound equipment.

**Jack H. Hancock** has been selected to supervise **Orbit Valve Company's** Rocky Mountain sales operation. Transferred from Casper, Wyo., where he was district manager, Hancock will headquarter in Denver.

**Walter J. Blair**, with **Food Machinery and Chemical Corporation's Peerless Pump** division, has been made process pump specialist. With the company for the past eight years, he will headquarter in Los Angeles, devoting his time to pump-application problems in refineries, petrochemical and chemical processes and other industrial plants.

**Walter H. Cox** has taken over as city sales representative for **Hercules Tool Company** in central and northeastern Oklahoma. He is filling a newly-created position with the company. Cox was with Oilwell Supply Company 17 years, with an eastern branch of Lee C. Moore and Company and more recently with Union Tank and Supply Company.

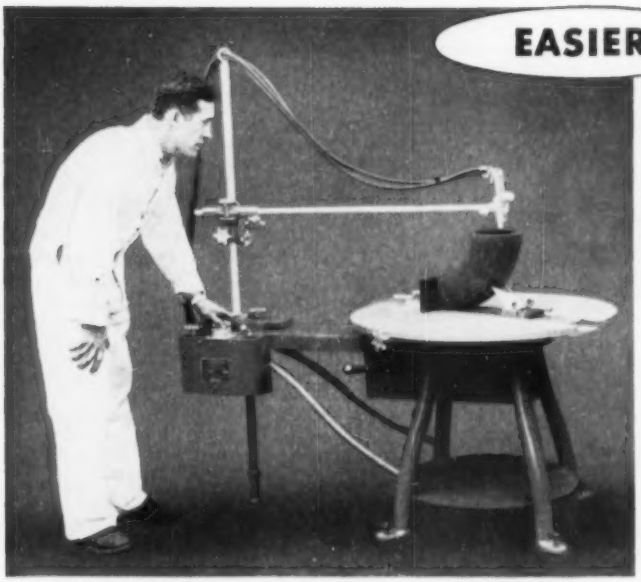
**John B. Scales** has been appointed technical sales representative of Chemical Ceramics division of **The U. S. Stoneware Company.** He will work out of the home office in Akron, Ohio.

**David M. Salls** is the new home office manager of **The Cooper-Bessemer Corporation's** Oil and Gas Industry Sales Engineering section. With the company since 1941, he will be responsible for coordinating the efforts of the home office in Mount Vernon, Ohio, with the field sales forces.

---

**Conoflow Corporation** has picked **Ernest L. Graves**, as a sales representative. Ernie Graves Company, with offices in Tulsa, will service Oklahoma. For the past seven years Graves has been in the sales-engineering field; the last two years as sales manager for a manufacturers representative in Tulsa.

**American Cyanamid Company** has opened a new sales office in Cleveland, Ohio, for the Refinery Chemicals department of its Industrial Chemicals division. The Cleveland Office will serve the Ohio area. **Charles H. Groezinger, Jr.** was transferred from Chicago to the new Cleveland



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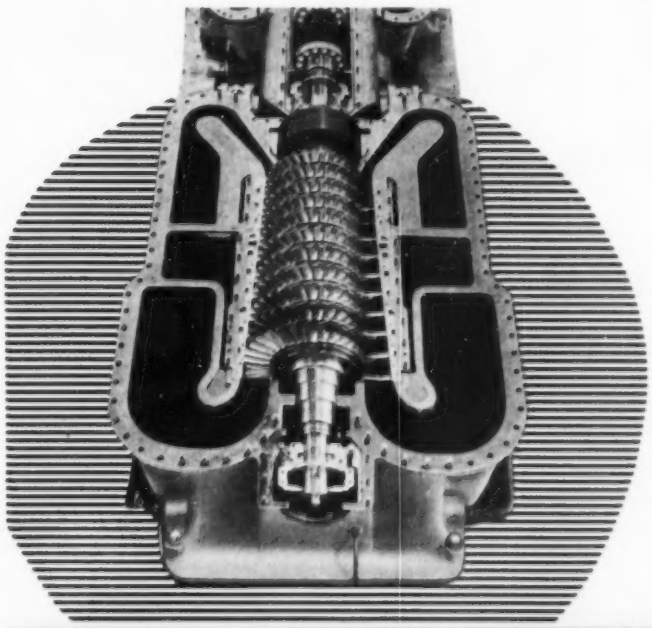

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## Suppliers . . .

office. Groezinger joined Cyanamid in 1950 as a sales trainee. Since 1952 he has served with the Refinery Chemicals department specializing in the sales and service of products for petroleum refining.

**U. S. Steel Corporation** has promoted **Wilbert A. Walker**, vice president, accounting, to comptroller of United States Steel Corporation. In his new position, Walker succeeds **Robert C. Tyson**, who continues as vice chairman of the finance committee. Walker also continues as a vice president. At the same time, **C. Burton Vernooy** will become assistant vice president of the corporation and **James L. Ortner**, assistant comptroller. Vernooy will also retain his present title of assistant comptroller.

**The National Supply Company** has promoted **Jay G. Carter**, district manager in Kansas, to assistant division sales manager for the Midwest. He will continue to headquarter in Wichita, Kansas, directing sales activities in that area. Carter joined the company in 1918 as a clerk in the store at El Dorado, Kansas, and was advanced to store manager, assistant district manager, and district manager. He has served as district manager since 1929.

Carter

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**Diamond Alkali Company** has elected **William H. Evans**, a vice president of the company, to the board of directors.

During his 18 years' service with the company, Evans has held a number of key executive posts, including that of treasurer.

For six years prior to his promotion to a vice presidency in 1954, Evans had been manager of the company's sodium silicate operations, which encompass six plants producing basic silicates and specialized derivative chemical products.

**Chase Brass & Copper Company, Inc.,** has appointed **George B. Moseley** as vice president in charge of sales. Moseley comes to Chase from the Firestone Steel Products Company of the Firestone Tire & Rubber Company in Akron, Ohio, where for the past seven years he has been general sales manager.

He was one time chief service engineer for Jack and Heintz, Inc., in Bedford, Ohio, and served Lincoln Electric Company, at Cleveland, in a sales capacity. From 1946 to 1949, he was sales manager of the Contract Manufacturing division of the Hupp Corporation, Cleveland.

**Eggelhof Engineers, Inc.,** has appointed **T. H. Pierson** as a vice president. He will head one of the company's processing divisions and assist in its overall management. The firm is headquartered at Houston.

Pierson

Formerly with Corn Products Refining Company, Pierson had been with that company eight years, serving successively as instrument superintendent and maintenance superintendent at the Corpus Christi, Texas, plant, and as assistant director of maintenance and later as technical staff assistant to the plant manager at Corn Product's Argo plant near Chicago. Before that he was with B. F. Goodrich Chemical Company at Beaumont, Texas.

**Rockwell Manufacturing Company** of Canada, Ltd., has begun production of Rockwell meter products in Canada for the first time at its Guelph, Ontario, plant and has opened a new sales office at Toronto. Meter servicing facilities and warehouse space have also been added at the Guelph plant. The new Toronto office is the first opened by the Canadian subsidiary of Rockwell Manufacturing Company.

**General Electric** has appointed **John S. Ryder** as employee relations specialist for the Distribution Assemblies department. Ryder will co-ordinate all department educational and training activities and be responsible for maintaining an effective communications program. He will also coordinate all labor relations and wage administration programs.

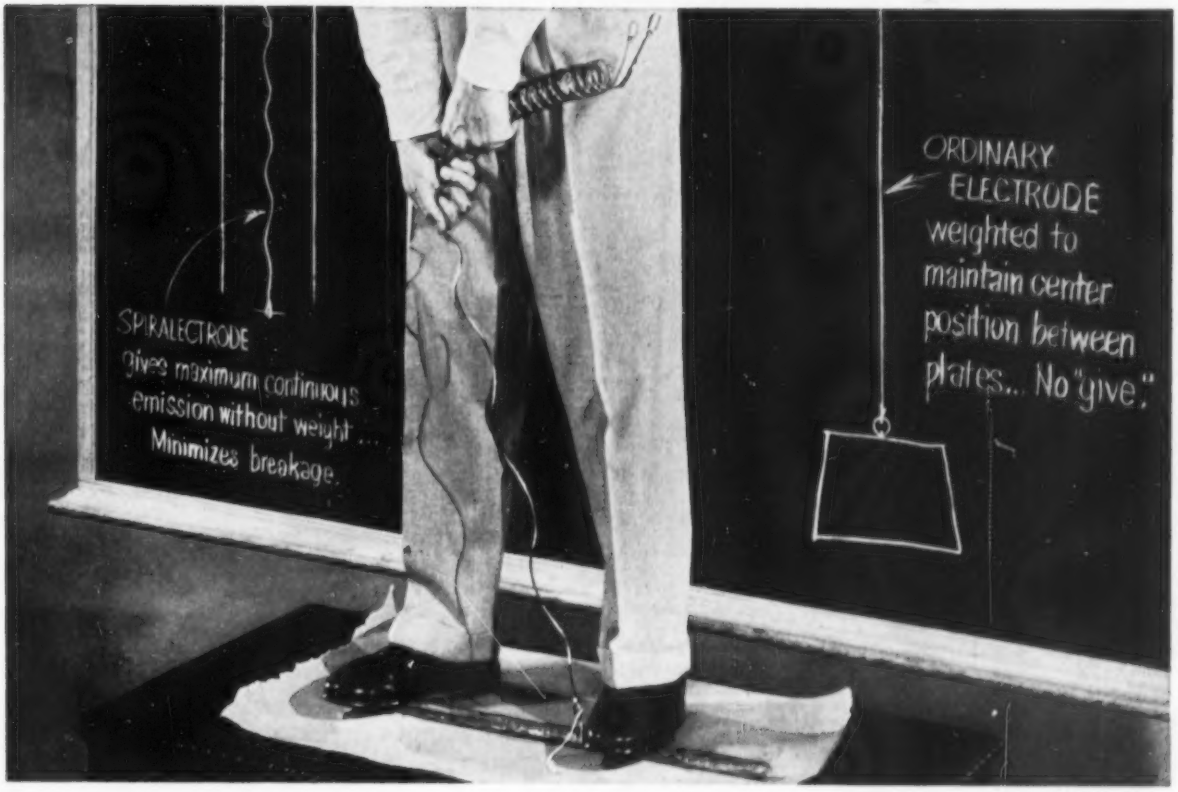
He has participated in the company employe relations development program since 1953. During this period, he has held training assignments in marketing, engineering, finance, and manufacturing at various company plant locations. He will make his headquarters at Plainville, Conn.

**Dravo Corporation** has appointed **John D. Purdy** as district sales engineer for the Chicago area. In his new assignment, Purdy will service the Chicago-Cook



For more data on advertised products, use Readers' Service Cards, last page.

# Electrode Breakage is no problem in Buell "SF" Electric Precipitators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gives maximum continuous emission without weight ... Minimizes breakage.
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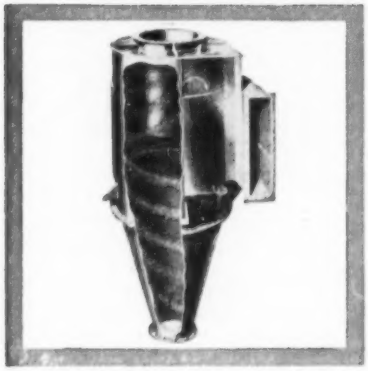
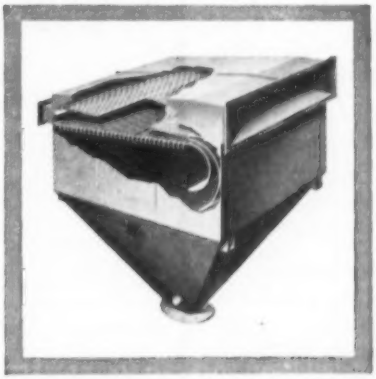
weighted to maintain center position between plates... No "give."



Buell Cyclones offer two "extra-efficiency" advantages: (1) exclusive shave-off which harnesses double-eddy and puts it to work, and (2), large diameter design which eliminates clogging.

Besides eliminating efficiency drops and "shutdowns" due to electrode breakage, Buell's unique Spiralectrode permits higher and more constant emission, extra efficiency. Also, Continuous Cycle Rapping—another Buell exclusive—keeps electrodes constantly clean for maximum performance!



Buell's Low Resistance Fly Ash Collector combines top efficiency with low draft loss, for natural or forced draft installations. Ideal for boilers from 100 to 2000 BHP.

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## Suppliers . . .

County area, northern Illinois, Indiana and adjacent areas from the company's Chicago office. Engaged in specialized equipment sales since 1938, he formerly was with George B. Limbert Company in Chicago.

**Koppers Company, Inc.,** has elected **Paul W. Bachman** vice president and director of research and development. Dr. Bachman will guide and direct the technical research and development functions of the company, with responsibility for developing research policies and objectives. **E. W. Volkmann,** who has been manager of Koppers' Research department for the past year, continues in that position.

**Petro-Chem Development Company** has appointed two new sales agents. Faville-LeVally Corporation, Chicago, will extend the territory they serve to include Illinois, Wisconsin, Michigan, together with northern Indiana, western Ohio and St. Louis, Mo. The G. M. Wallace Company, Denver, will serve Montana, Wyoming, Colorado and most of New Mexico.

**Armour and Company** has made Bradford Supply Company its Tri-State sales agent for the Chemical Division in Illinois, Indiana and Kentucky. Warehouse stocks will be maintained at Robinson, Ill. and Owensboro, Ky. **Leslie Barnhart** will be in charge of Bradford's operation and he will have the assistance of the Armour laboratory and technical service organizations.

Duncan

Allinson

**Beckman Instruments, Inc.,** has named **Donald C. Duncan** as general manager of its Berkeley division. At the same time, **Thomas Allinson** was appointed manager of the Berkeley division, located in Richmond, Calif. Allinson will report to Duncan who will continue to serve as general manager of Beckman's Helipot and Arga divisions in South Pasadena.

Duncan was an industrial control test engineer for General Electric, Schenectady, N. Y., in 1940, and from 1941 to 1945 served with the Navy's Bureau of Ships in Washington, D. C., as an electrical engineer.

Allinson joined Berkeley in 1951 as plant manager. In 1954 he was named marketing manager directing advertising and sales promotion, market research and sales activities of Berkeley's nuclear instruments, analogue computers, counters, timers, recorders and high frequency measuring instruments.

**Union Carbide and Carbon Corporation** has made **E. L. Meadows** supervisor of marketing information services for Carbide and Carbon Chemicals Company, a division of the corporation. He will be responsible for organizing and expanding a Marketing Information center which will service all marketing groups in Carbide and Carbon.

Meadows joined Carbide and Carbon in 1927 as laboratory assistant at Mellon Institute. In 1929 he was transferred to the general sales office in New York and in 1950 he was appointed district office manager for the Newark district sales office.

**The Dow Chemical Company** has advanced **Floyd J. Gunn** to manager of the Los Angeles office. He had served as manager of coatings sales for the company's Plastics department for the past six years. He succeeds **Homer L. White** who has held the post since 1950 and will now take over an assignment on the company's production control staff in Midland.

**Atlas Powder Company** has retired two directors and elected a new board member. Retiring from the board are **Charles Warner,** a director since 1927, and **Cecil F. Backus,** a director since 1929. The new director is **Wilfred D. Gillen,** president of The Bell Telephone Company of Pennsylvania and The Diamond State Telephone Co.

**Davison Chemical Division** of W. R. Grace & Company has named **Frank G. Ciappetta** as its new director of catalytic research. He has been in charge of catalytic research for Socony Mobil Oil Company, Inc., at Paulsboro, N. J. Dr. Ciappetta joined the Research and Development department of The Atlantic


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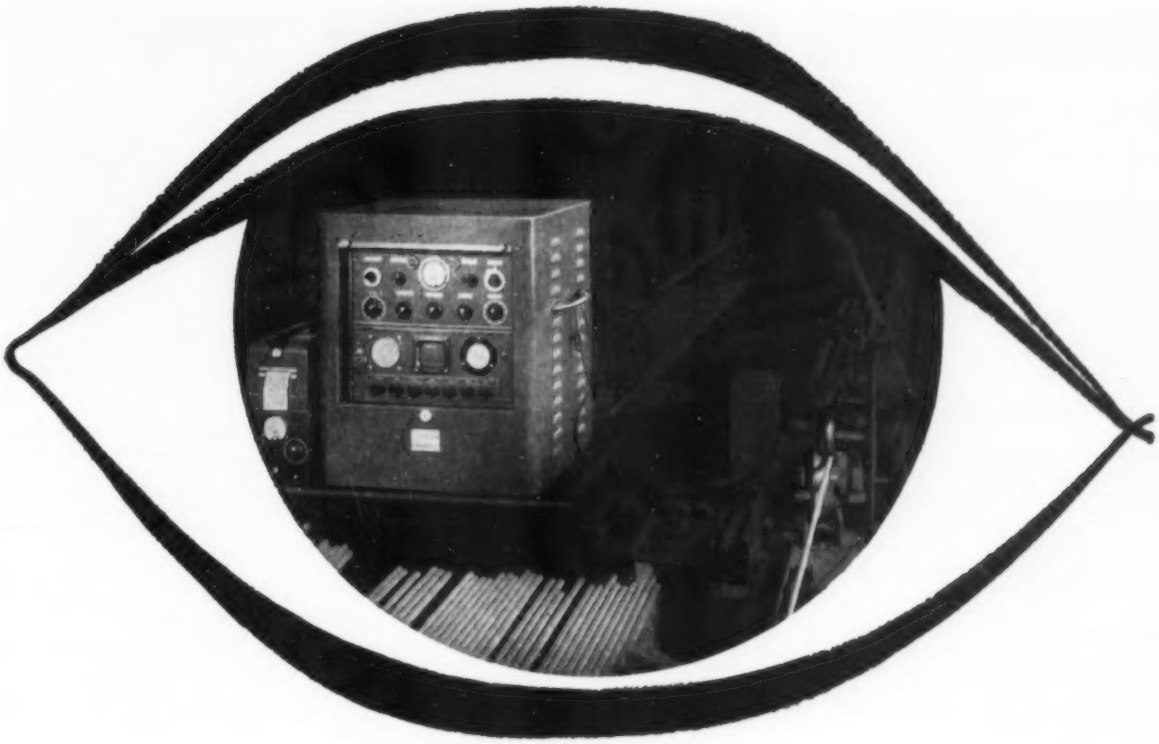

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**Carpenter**

**Stainless Tubing & Pipe**

## Suppliers . . .

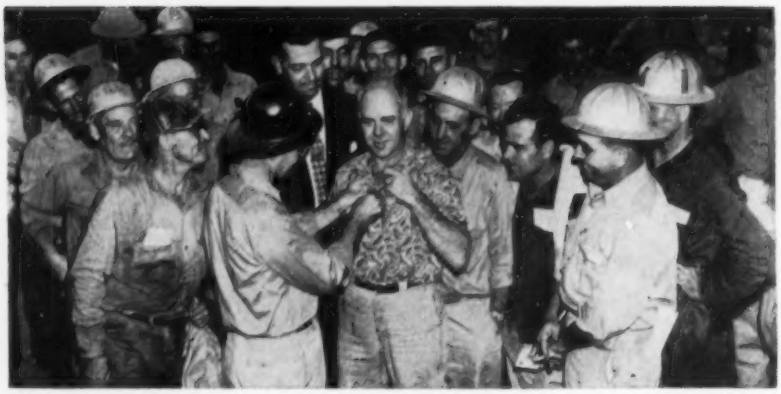
Refining Company in 1939, and was principal chemist in charge of the Catalytic Process group at Atlantic when he joined Socony in 1951.

**Alan Wood Steel Company** has appointed **William W. Ogren** as general sales manager of its Penco Metals Products division. He will supervise all division sales activities.

Ogren had been associated with Lyon Metal Products, Inc. seven years and was Philadelphia District Sales Manager for that company prior to joining Penco. He joined Timken Roller Bearing Company as a salesman in 1947 and became associated with Lyon Metal Products in 1948.

**Walworth Company** has elected **D. Frank Mederos** as vice president and assistant to the president. In addition to his new duties, Mr. Mederos will continue to have charge of all sales of Walworth products in Canada. The company's Eastern Division and Boston Branch sales also will continue under his direction.

**Ethyl Corporation** has made two new promotions in its Gasoline Testing division. **William C. Ludt,** who has been manager of the Gasoline Testing laboratory at North Kansas City, Mo., for the past seven years has been appointed assistant manager of the gasoline testing division with headquarters at Yonkers, N. Y. **Edward J. Otto** has been promoted from deputy manager of the North Kansas City laboratory to manager.



**385 Years of Service—**

**Gold pins symbolizing a total of 385 years of service with Delta Tank Manufacturing Company, Inc., were awarded to 55 members of the Delta production staff at recent plant ceremonies in Baton Rouge, La. Anthony A. Browning (above, center), warehouse superintendent, has his 15-year badge pinned on him by Ed A. Watlington, Delta's plant superintendent. Twenty Delta workers received 10-year pins from General Works Manager Arch L. Graham (left center) while 34 other employees were awarded five-year pins. Two or more members of at least six families were among those receiving Delta service badges.**

**Solvay Process Division,** Allied Chemical & Dye Corporation, enters its 75th year of chemical manufacturing in 1956 with completion of its new hydrogen peroxide plant at Syracuse, N. Y., and with work on new chlorine-caustic soda facilities at Brunswick, Ga., well under way.

The hydrogen peroxide installation, which uses a new process, is near the site of one of America's first chemical centers. It was at Syracuse that Solvay, founded in 1881, built the country's first soda ash plant. Before that, U. S. requirements of soda ash had to be imported.

**The Dow Chemical Company** has opened a sales office in Buffalo, to service a territory that covers part of New York state, extending east to Utica. It will serve a 10-county section of northwest Pennsylvania.

Manager of the office is **Eugene L. Martinez,** who was advanced to the post after nearly 10 years as general chemicals sales-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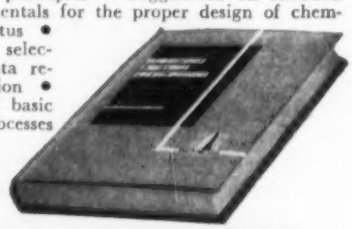

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# Are your valves over their heads in corrosive reducing solutions?

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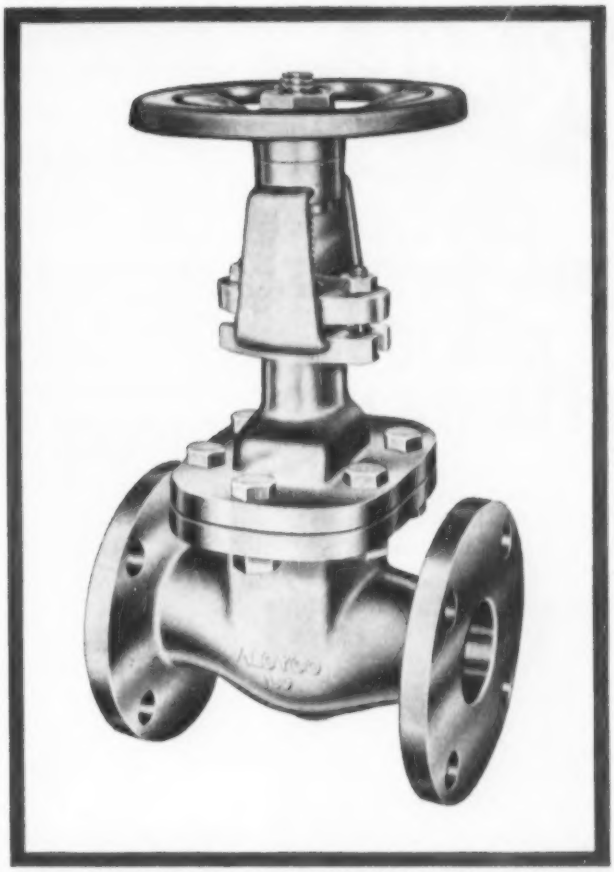

**ALOYCO MONEL VALVES** are used extensively in handling alkalies, salt waters, food products, organic substances, and many air-free acids.

Keeping corrosive solutions of mineral and organic acids, alkalies and salts under control is a job for Aloyco Monel or Nickel valves.

Monel valves are especially good for handling hydrofluoric acid which is used as a catalyst in one process for the production of high octane gasoline. Monel and Nickel have exceptional resistance to neutral and alkaline salt solutions, including chlorides, carbonates, sulfates, nitrates and others. Nickel is more resistant than Monel to more concentrated NaOH solutions at elevated temperatures and is usually preferred when contamination of the caustic with copper or iron would be objectionable.

Nickel, although similar to Monel in corrosion resistance, has generally an inferior resistance to acids, about the same resistance to salts and a little better resistance to alkalies.

Both alloys are available in a wide range of Aloyco valve designs. They're cast by induction melting at Aloyco foundries and machined in Aloyco plants. New bulletin #9, couponed below, provides complete information. Write today to ALLOY STEEL PRODUCTS CO., INC., Linden, N. J.

57

**Alloy Steel Products Company, Inc.**
**1303 West Elizabeth Avenue**
**Linden, New Jersey**

**Gentlemen:**

Please send me a free copy of your Bulletin No. 9 on Monel and Nickel valves.

Name_____

Firm_____

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RIGHT WHERE IT COUNTS!

IRVING "GRIDSTEEL" CONTOUR RETAINER MESH

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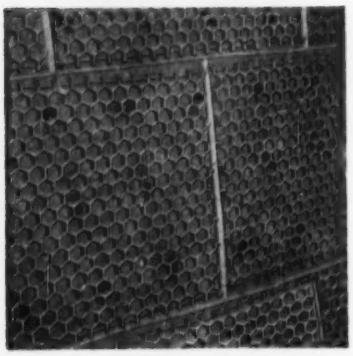
Castable Ganister Linings
in Refractionating Units
in Petroleum
& Chemical Industries



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★ Thermal Cracking Units
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REDUCE EXPENSIVE SHUTDOWNS
by using
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ESTABLISHED 1902

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## Suppliers . . .

man with the company's office in New York City.

The sales staff includes two chemicals salesmen, **Seward H. Mott, Jr.**, and **Gerald L. Mitchell**, and four plastics salesmen, **Ross D. Visger**, plastics supervisor, **Robert F. Bunker**, **Robert S. Crew** and **Donald W. Ruoff.**

**United Supply and Manufacturing Company,** headquarters in Tulsa, recently opened a new supply store at Lindsay, Okla. **W. H. Welsh** is manager of United's newest supply store.

**Westinghouse Air Brake Company** has named **Paul Azzolina** as manager of the Service department for its Le Roi division. He was formerly assistant manager of the Service department. As manager of the department, he will be responsible for supervising field servicing of all Le Roi products.

Azzolina

Starting with the company in 1936 as a catalog clerk, Azzolina has held various positions since then, including those of expeditor, order analyst, parts correspondent, service sales correspondent, parts manager, and assistant service manager.

**The Pfaudler Company** has elevated **Ranlet Miner** to chairman of the board, and **Donald A. Gaudion** has been made executive vice president. Miner, vice chairman of the Pfaudler Board since 1951, succeeds his father, the late **Edward G. Miner.** Gaudion had been a vice president of the company since 1952. He has also held the position of assistant to the president for six years.

**Ehrhart & Associates, Inc.,** has been retained by Wilshire Oil Company, Norwalk, Calif., to perform the engineering service on a $1 million Marine Terminal at Huntington Beach, Calif. The terminal will be used to service the company's refinery with foreign crude oil.

**Stratford Engineering Corporation** has appointed D. D. Foster Company, a Pittsburgh firm, as its sales representative for western Pennsylvania; eastern Ohio; Boyd County, Ky.; West Virginia, and Garrett and Alleghany counties in Maryland.

**Allied Chemical & Dye Corporation** has appointed **Frank J. Kiernan** technical engineer of protective coating sales for its Barrett Division. He was formerly assistant chief engineer of the U. S. Stoneware Company, and, prior to that, project leader and developments engineer for Stauffer Chemical Company.

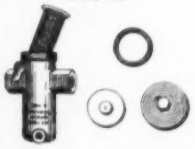
**General Electric** has **Lee T. Ellis** as its new manager of the Mining and Chemical Systems Sales unit, Systems Sales section. He joined G.E. the same year, and was assigned to the Test Course both at Philadelphia and Schenectady.

**American Gilsonite Company** has made **Arthur S. Klopf** manager of marketing. Klopf will direct all sales and market-

A Complete Line of COMBUSTION ACCESSORIES for Every Industrial Liquid Fuel-Gas Installation

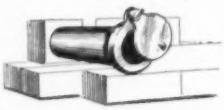
Air Control Door and Frame, top hinged, ratchet type, heavy duty, for manual control. Surfaces are machined to a close fit.

Fuel Oil Suction Strainer, single type. Large basket area insures low pressure drop; cover and basket easily removed for cleaning.



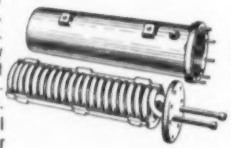
Wide-View Peephole, safety, curtain type. Cobalt glass removed to show bearing surface for curtain. Curtain halves are interlocked—open simultaneously.

Ignition Port with Refractory Tile No. M896 . . . for use with standard 3" pipe. Also serves as a peephole.



Furnace Relief and Access Door, heavy construction, practically air tight. Door casting correctly weighted, lined with plastic refractory retained by imbedded grill; with observation port and cover.

Fuel Oil Heater, Self-Cleaning, Spiral Coil Type. High oil velocity in coil, resultant turbulence prevents carbon formation. No internal connections or joints.



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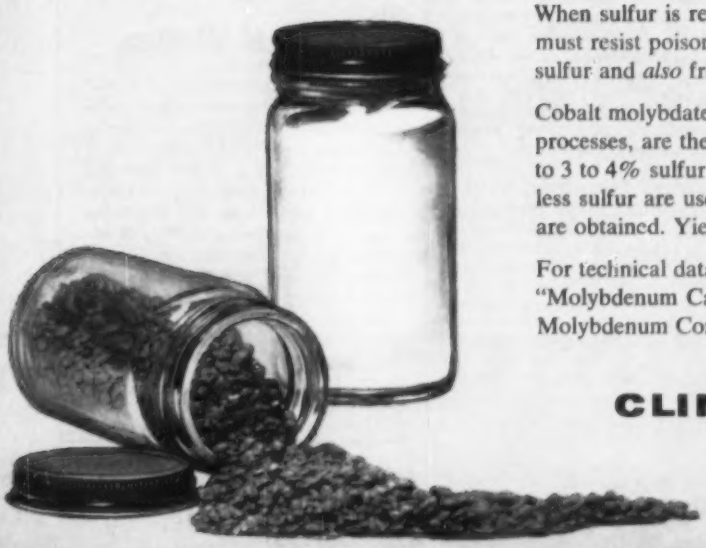
INDUSTRIAL OIL BURNERS, GAS BURNERS, AND FURNACE EQUIPMENT

# Moly catalysts resist poisoning



When sulfur is removed from petroleum stocks, the catalyst must resist poisoning. It must withstand contamination from sulfur and *also* from nitrogen and metallic contaminants.

Cobalt molybdate catalysts, in a number of different commercial processes, are the answer to these difficult specifications. Stocks up to 3 to 4% sulfur by weight have been processed. When stocks with less sulfur are used, products containing as little as 0.1% sulfur are obtained. Yields are almost 100% of theoretical.

For technical data about molybdenum catalysts write for our bulletin "Molybdenum Catalysts for Industrial Processes." Dept. 25, Climax Molybdenum Company, 500 Fifth Avenue, New York 36, N. Y.

**CLIMAX MOLYBDENUM**

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If corrosion problems are making your maintenance costs soar . . . call James Bute Company for competent technical advice. Bute's specializes in all types of organic coatings.

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Send specifications for quotations and prompt-delivery schedule.

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## Suppliers . . .

ing activities of the company including products from their new gasoline refinery and metallurgical coking plant now being erected near Grand Junction, Colo. He was formerly general sales manager of the Missouri Coke and Chemical division of the Great Lakes Carbon Corporation.

**Orbit Valve Company** has named **Joseph F. Brunsman** as its field representative for the San Juan basin, with headquarters in Farmington, N. M. Before joining the company Brunsman was with The National Supply Company at Worland and Cody, Wyo. The appointment was made in line with an expansion in the company's Rocky-Mountain sales force.

Brunsman

**U. S. Steel Corporation** has appointed **Carl R. Nelson** as district representative, refinery and pipeline sales at Charleston, W. Va., for its Oil Well Supply division.

Nelson was employed by "Oilwell" in 1941 at Bradford, Penn. In 1949 he was appointed assistant district material supervisor at Bradford, Penn. In 1950 he was named store manager at Charleston W. Va., where he was located prior to his present appointment.

**The International Nickel Company** has appointed **Emil G. Holmberg** to the Corrosion Engineering section of its Development and Research Division in New York.

Before joining Inco, Holmberg for nine years was chief metallurgist of the Alloy Steel Products Company, Linden, N. J., prior to which he had served 11 years as metallurgist with E. I. du Pont de Nemours & Company, and for three years as an instructor in engineering subjects at the Newark School of Fine Industrial Arts, Newark, N. J.

**Hooker Electrochemical Company** has elected **Robert E. Wilkin** to the company's board of directors. He was also named vice president and director of sales. Wilkin was formerly vice president and general sales manager.

**Pittsburgh Coke & Chemical Company** has appointed **Robert J. Woodside** as technical sales representative for its Activated Carbon division in the Gulf Coast area. He will make his headquarters in Houston. Woodside came to Pittsburgh Coke & Chemical Company from Hagan Corporation, where he was in the Engineering and Sales departments.

**Phillips Chemical Company,** wholly owned subsidiary of Phillips Petroleum Company, is establishing a new district office of its Plastics Sales division at Akron, Ohio. **W. M. Larsen** has been promoted to manager of the new office. The staff of the New York plastics sales office is being enlarged with appointment of **M. B. Bistline** as sales engineer. Before their new promotions, Larsen was marketing assistant in the parent company's Sales department and Bistline was a development engineer in Phillips Research and Development department.

**Weston Electric Instrument Company** has **Wilbert H. Steinkamp** as a new vice president in charge of sales. He will be responsible for the direction of Weston's sales in all domestic and foreign markets.

Steinkamp has 26 years experience in the instrument field, handling the sales and

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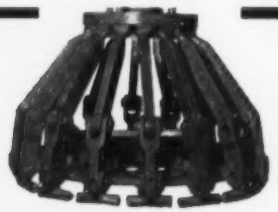

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*Filling and Crimping Equipment*
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PETROLEUM REFINER has prepared a booklet for the editors and those within the industry who may write technical articles for PETROLEUM REFINER or others of the technical press. This booklet also contains valuable suggestions on preparing papers for technical meetings or reports. Each subscriber to PETROLEUM REFINER may have a copy free of charge, just by asking for it. Use the blue "Reader's Service" card on the back of this issue. Write in "Free Author's Booklet," fill in name, address and mail. No charge, no obligation.

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For further assistance on your explosion-proofing problem, just call the nearest Crouse-Hinds office listed below. Our field engineers are *electrical* engineers, fully qualified to make specific recommendations for your plant.

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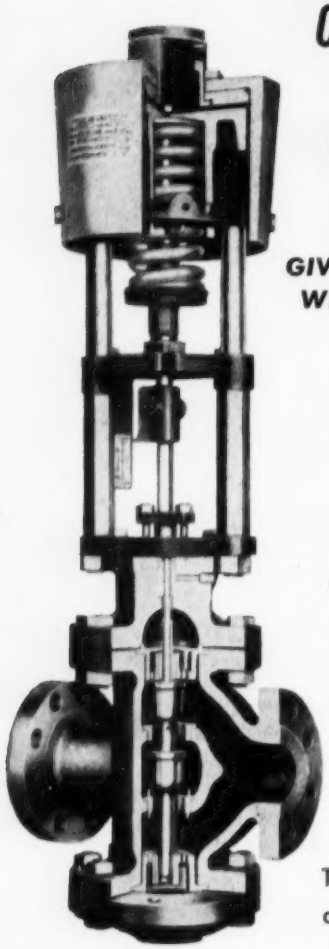
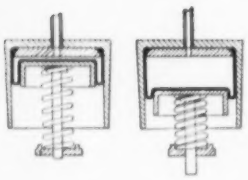
# FOR FLUID CONTROL

## THE NEW FOSTER CONTROL VALVE with ‹ISOFORCE› actuator



**GIVES YOU MORE POWER WHEN YOU NEED IT . . .**



. . . with the Foster Bellofram construction, no force is lost at end of the stroke where spring compression requires the maximum force. This assures linearity of instrument and stem positions. These new control valves are available in sizes starting at ½" with materials and end connections to suit operating conditions.

*For complete technical information, ask for Bulletin CV-1*

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- AUTOMATIC VALVES
- CONTROL VALVES
- SAFETY VALVES
- FLOW TUBES


## Suppliers . . .

marketing of industrial, laboratory and electronic instruments and components to all major industrial markets both in the U. S. and abroad.

Prior to joining Weston, he was vice president and general sales manager of Beckman Instruments, Inc. Before his affiliation with Beckman in 1952, he spent 22 years with the Brown Instrument Company as industrial instrument salesman, district manager and general sales manager.

**Allied Chemical & Dye Corporation** has named **Frank J. Kiernan** as technical engineer of protective coatings sales for Barrett Division. He was formerly Assistant chief engineer of United States Stoneware Company, and, prior to that, project leader and developments engineer for Stauffer Chemical Company.

**Infilco, Inc.,** has organized a new unit, the Ion-Exchange division, under the supervision of **Howard W. Frazer.** He has been a leading field engineer for the company since 1949, specializing in ion-exchange treatment. His experience includes close association with many of the largest ion-exchange treatment plants in states bordering the Great Lakes.

**U. S. Steel Corporation** has elected **Charles H. Bell,** Minneapolis, Minn., was elected a director. Bell, president of General Mills, Inc., succeeds **Sewell L. Avery,**


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**Makes Higher Heat Resistant Concrete**

Haydite aggregate used with Lumnite cement produces refractory concrete suitable for sustained temperatures up to 1800-2000° F., which makes it excellent for tubular heaters, ducts, flues, stacks and catalytic crackers. Weighing from 30 to 40 per cent less than ordinary aggregate concrete, Haydite is exceedingly strong. It has excellent insulating properties and withstands pressures of up to 1130 pounds per square inch. Write today for free folder and complete information about Carter-Waters Refractory Haydite.
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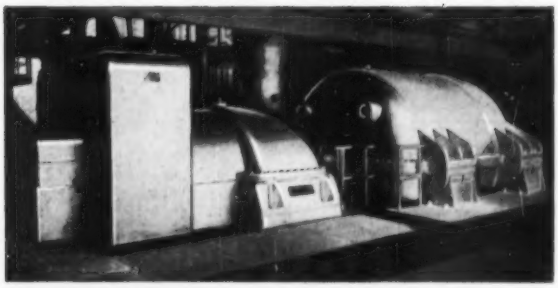
# Pointing the way to non-stop performance

## ELLIOTT CENTRIFUGAL COMPRESSORS



**ONE OF THE LARGEST CENTRIFUGAL COMPRESSORS IN SERVICE TODAY**

This Elliott compressor, installed in a southwest refinery, handles 135,500 inlet cfm of air at 22.0 psig discharge pressure.

Take a good, close look at this Elliott Multistage Centrifugal Compressor. Note its simplicity and ruggedness of design and construction. It's easy to see why these compressors have been setting non-stop service records in refineries. They're built for the "long run."

Elliott Centrifugal Compressors are available in both single and multistage types, for inlet capacities up to 175,000 cfm, and discharge pressures up to about 2000 psig. Drive may be turbine, gear-motor combination or direct-connected motor, all built by Elliott. For details write Elliott Company, Centrifugal Compressor Dept., Jeannette Pa.

**ELLIOTT Company**

PS-1A

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Foremost Metallizers

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QUICKLY, PERMANENTLY
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*In stock — all supply stores*

**M. B. SKINNER COMPANY**
SOUTH BEND 21, INDIANA, U. S. A.


## Suppliers . . .

Chicago, who has retired from the U. S. Steel board after serving as a director since 1931.

**Rockwell Manufacturing Company** has appointed **John Robert Diamond** to a newly-created position as personnel manager. Since 1950, he had served as manager of procurement and selection for Pennsylvania Salt Manufacturing Company. The personnel office, previously a part of the Industrial Relations department, now will operate as a separate department.

Diamond

**Atlas Powder Company** has appoined **Edward J. Massaglia** as assistant general manager of the Chemicals division. Massaglia formerly was vice president and director of Pfizer International, Inc., serving with that organization from 1951 to 1955.

Prior to that, he was engaged in development and manufacturing work for Charles Pfizer & Co., Inc., parent company of Pfizer International. He also served as a development engineer for Niagara Alkali Co. and production manager for Benzol Products Co.

**Dresser Industries, Inc.,** elected **Robert B. Anderson** to membership on its board of directors and the executive committee. Anderson, recently named president of Ventures, Ltd., a Canadian mining company, has a distinguished career as Secretary of the Navy and Deputy Secretary of Defense in the Eisenhower Administration. Prior to his government service he had an outstanding career in the oil business as attorney and general manager for the W. T. Waggoner Estate in Vernon, Texas.

**Walworth Company** has completed an exchange-of-stock agreement with **Conoflow Corporation.** As a result of the agreement, Conoflow will become an operating subsidiary of the Walworth firm.

As an independent subsidiary, Conoflow will operate under its same policies, with no change in management or personnel. It also will retain its Philidelphia plant.


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SUSPENDED WALLS ARCHES
FOR PRESSURE VESSEL LININGS HEATERS • BOILERS

- INSULATION
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**SIGHT FLOW INDICATORS**
***"See What Goes On Inside"***

*For insertion into pipe*
**FOR EVERY APPLICATION**
BRONZE, IRON, STEEL, STAINLESS STEEL

**FIG. 29** Cylinder with Impeller

**FIG. 17-28** Cylinder

**FIG. 215** Flanged

**FIG. E-57** Double Window

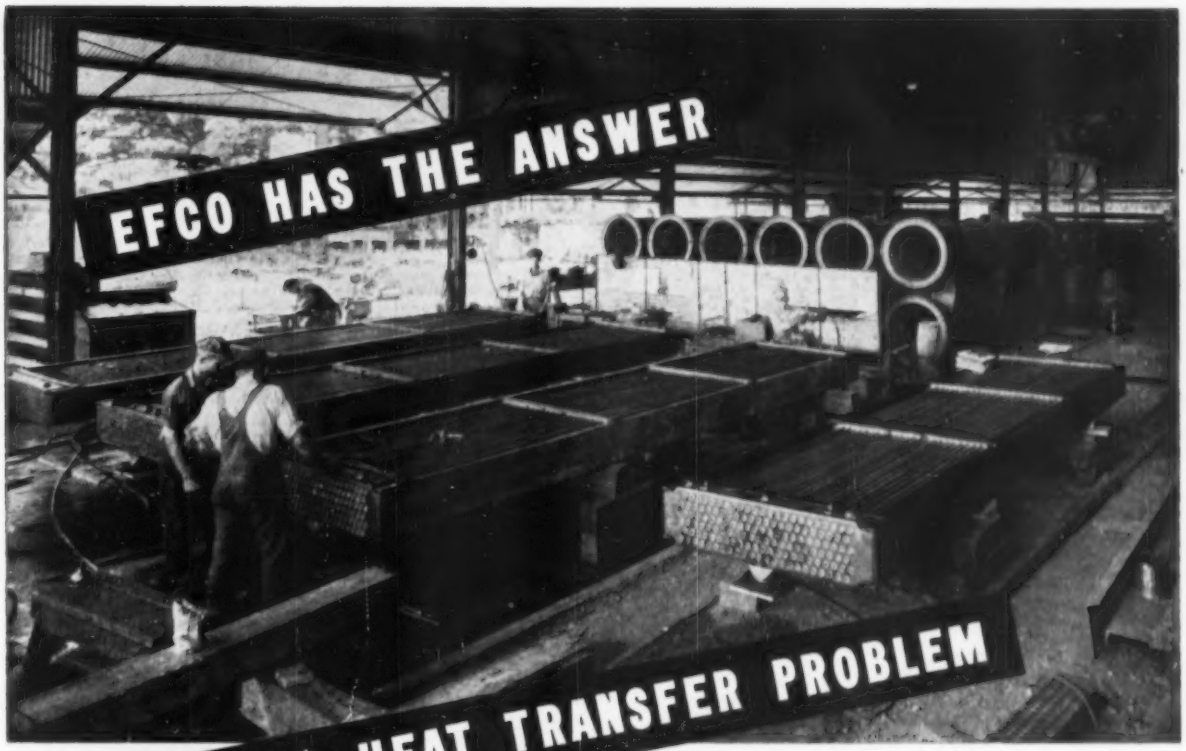
**FIG. 212** Visibility Welding Neck or Screw

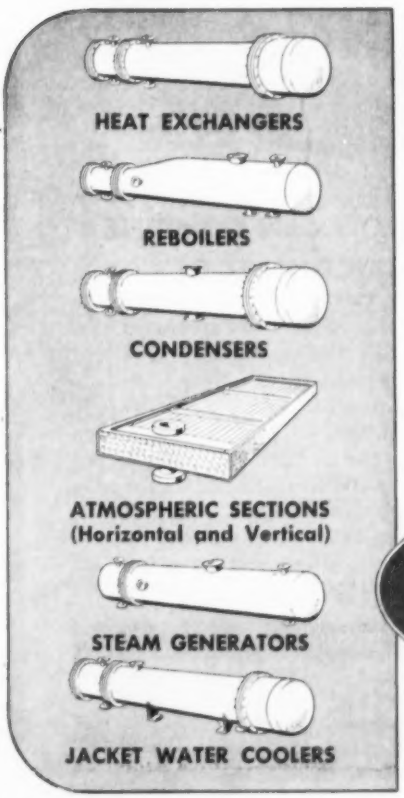
**FIG. E-811** Flapper

**FIG. E-1810** Rotating Wheel Type

All sizes up to 6" *Send for Catalog*

**ERNST WATER COLUMN & GAGE CO.**
**LIVINGSTON, N. J.**




● If your problem is the poor performance or high maintenance cost of your heat transfer units, consult an EFCO engineer. He will help you decide the changes or modifications necessary to get the desired performance from your heat transfer equipment.

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HEAT TRANSFER EQUIPMENT

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This nickel alloy casting by the Curtiss-Wright Metals Processing Division costs 40% less than identical previous castings. The saving, however, is almost a sidelight to the fact that specialized know-how can discover routes to quality that are often far shorter as well as less expensive.

**High Standards, Lower Cost**

In this case the answer to meeting high standards and lower cost was ceramic mold instead of investment casting. This method in experienced hands retained the close tolerances required . . . produced castings faster, and with gratifying economy.

Metals Processing Division metallurgical specialists can find answers for you, whether in ceramic, shell, centrifugal or other techniques . . . standard or special. You will profit by long-proven engineering ability and unmatched facilities in production and testing. When requirements are critical, when precision must be combined with resistance to heat, stress, wear and corrosion, it's time to call on Curtiss-Wright–a primary source for castings, forgings and extrusions.

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# PETROLEUM REFINER Classified Ads

**Petroleum Refiner New Classified Rates**

**RATES:** Regular Classified (undisplayed) set in this size type: 12 cents per word. Minimum charge, $3. Blind box address in our care counts six words. Replies forwarded without charge. Situation wanted ads, 6 cents per word. Display ads, set in suitably larger type with ruled border, $12 per column inch; situations wanted display ads, $6 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. **All Classified ads payable in advance.** Copy deadline: 25th of month preceding date of issue. Send copy and checks to: Classified Advertising, Petroleum Refiner, P. O. Box 2698, Houston, Texas.

* * * * * * * * * * * * * * * * *

## PROFESSIONAL SERVICES

• HIGH voltage electrodeless discharge is on its way as one of the new tools in petroleum refining. High voltage discharge eliminates sludge formation! High voltage discharge removes gases and water! High voltage discharge improves high temperature greases! High voltage discharge makes lubricants from non-lubricants! Let us describe the use of this new tool. No obligation, of course. Research and Development Corporation, 21 East Van Buren Street, Chicago 5, Illinois.

## FOR SALE

*For the first time in history—*

**2 LAMSON CARTON PALLETIZERS *for sale!***

Immediate inspection and shipment, still erected, two Lamson automatic "pallet loaders", latest design, as used by Esso Standard Oil, (Baltimore, Baton Rouge, Bayonne), Gulf Oil, Standard Oil (Ohio), Sun Oil, Tide Water Associated Oil, Union Oil Co. of Calif., H. J. Heinz, Hershey Chocolate, Lever Bros., Procter & Gamble, Anheuser-Busch, Ballantine, California-Hawaiian Sugar, Ralston Purina, Falstaff, Liebmann, Lucky Lager, San Francisco. AC motors, three "cartridges" for different carton load, approx. 1400' belt conveyor and drives; can be purchased complete or individual units, **prices approx. 50% of new,** subject to prior sale. Box 221-R, PETROLEUM REFINER, Houston, Texas.


**Save on Your INDUSTRIAL TRACK**

**FOSTER QUALITY** — FULLY GUARANTEED

**RELAYING RAILS**

Handle more cars better—cost less to install and maintain. Foster stocks all Rail Sections 12# thru 175#, Switch Material and Track Accessories.

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Master **GLASSES**

**HIGH PRESSURE GASKETS**

All sizes to fit your gages
**ERNST WATER COLUMN & GAGE CO.**
Send for Catalog — LIVINGSTON, N. J.


## SITUATIONS WANTED

• EXPERIENCED manufacturers' representative now contacting key men in refining, natural gasoline, petrochemical plants in Texas and Louisiana desires to take on additional lines. Box 219-R, Petroleum Refiner, Houston, Texas.

**CHEMICAL ENGINEER**

Extensive broad experience including policy decisions, plant operations, construction, pilot plants, research and development on sulphur, inorganic sulphur compounds, sulphur compounds in petroleum, petroleum refining operations, bulk oxygen, caustic, chlorine, soda ash, potash, cement, heavy plant utilities. Engineering degree, some teaching, independent consultation work. Twenty years industrial background. Age 43. Current position not utilizing full capabilities. Desire opportunity to put diversified industrial experience to work examining engineering problems, recommending solutions, supervising operational policy. Box 217-R, Petroleum Refiner, Houston, Texas.

## HELP WANTED

***Plant Equipment Inspectors***

Graduate engineers with minimum 5 years' experience in design or inspection of petroleum processing plants and equipment. Major part of experience must have been in inspection work entailing general knowledge of all facilities. Develop inspection methods, supervise and conduct inspections and advise operations on codes and equipment limitations in a major oil installation located in Saudi Arabia.

*Write giving full particulars regarding personal history and work experience. Please include your telephone number.*

Recruiting Supervisor, Box 91

**ARABIAN AMERICAN OIL COMPANY**

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## HELP WANTED

• METALLURGIST to head laboratory and technical sales for leading manufacturer of Stainless Steel processing equipment. Give complete resume and salary requirement. Box 220-R, Petroleum Refiner, Houston, Texas.

**WANTED:**

**Sales Engineer**

Chemical Engineering Graduate, with 3-6 years Process Experience in Oil Refining or Petro-Chemicals. To handle Sales of Major Process Equipment in Texas and Louisiana, with headquarters in Houston. Salary open, car and expense account furnished. Excellent opportunity with locally owned manufacturers representative. Address letter to Box 363-R, c/o Petroleum Refiner, Houston, Texas.

**AREA ENGINEERS**

Several graduate engineers with minimum 5 years' experience supervising maintenance engineering functions in oil refining or producing facilities, power plants, heavy industrial installations, manufacturing plants, or related operations. To establish technical supervision, procedures, maintenance operations and schedule routine and special work for major oil producing and refining operation with all supporting facilities; i.e., housing, feeding, recreation, etc.

Salary commensurate with background and experience. Write giving full particulars regarding personal history and work experience. Please include telephone number.

*Recruiting Supervisor, Box 65*

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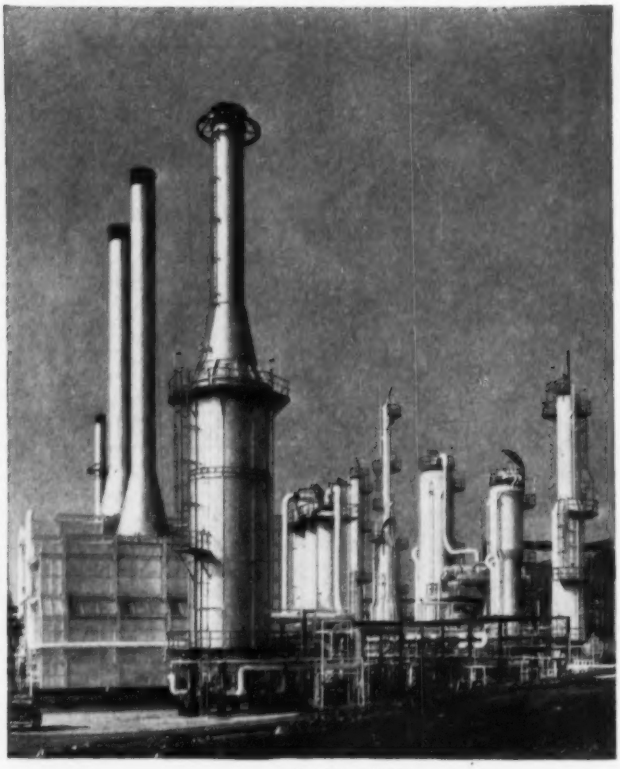
**INTERESTED IN UNIFINING* FOR DESULFURIZATION AND UPGRADING**



• Unifining Unit
Union Oil Company of California refinery
Oleum, California

**UNIFINING should be of particular interest to all operators of catalytic reformers which produce by-product hydrogen.**

• Harshaw is the exclusive producer of the Union Oil Company of California cobalt-molybdate catalyst used in the recently announced "Unifining" desulfurization and upgrading process. This rugged, commercially proven catalyst is supplied in the form of cylindrical tablets conforming to rigid physical and chemical specifications established by Harshaw and Union Oil Company of California. Stability at high temperatures permits repeated regenerations if and when necessary.

Please contact Harshaw for further information on this catalyst.

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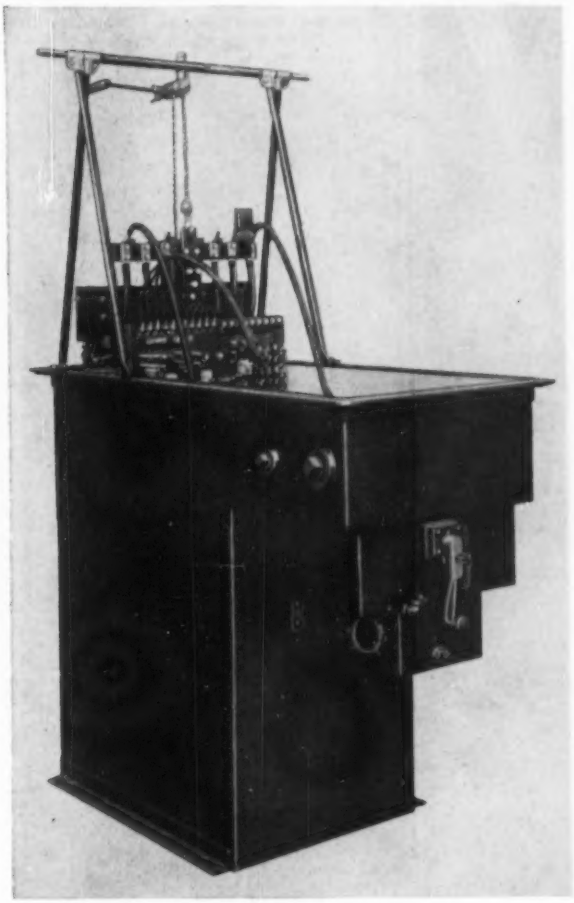
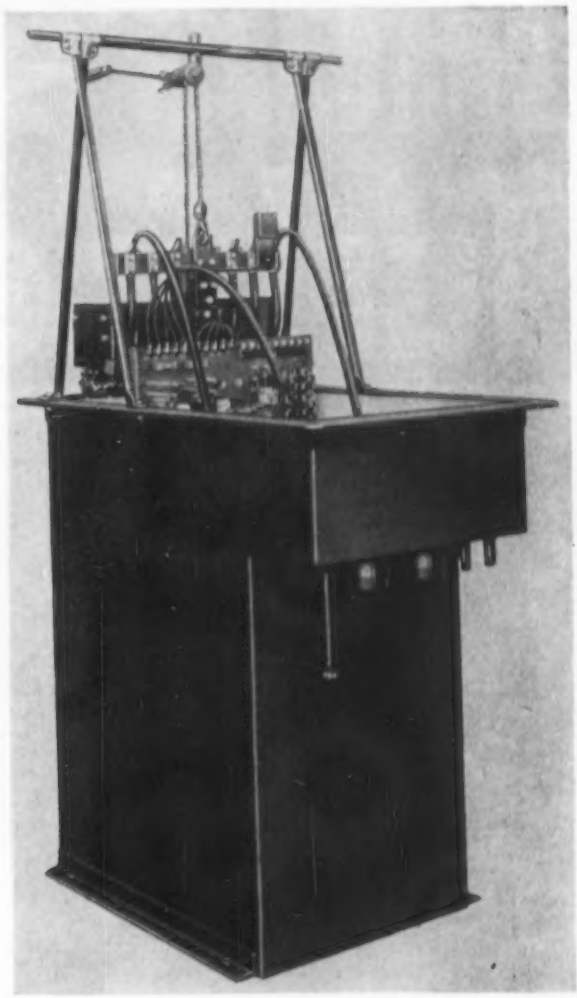
* Trademark of Union Oil Company of California

# What's New In Equipment . . .





**New Combination Unit—**
**A totally oil-immersed starter with threaded conduit couplings is shown at the right. The starter above is equipped with an oil-disconnect switch.**

## New Oil-Immersed Starter Designed To Withstand Corrosive Atmosphere

**The Electric Controller & Manufacturing Company** has announced a totally oil-immersed starter which is claimed to have a superior ability to withstand highly corrosive atmosphere.

Originally designed for oil-refinery use in semi-hazardous locations, the starter is useful for petrochemical and other industries where corrosion is a problem.

The new starter is of totally oil-immersed design with contactor, relays and all electrical units under a large head of oil. The contactor, which has certified 50,000 KVA interrupting capacity, is the company's ZHS Magnetic type. All power and control leads are brought out of the oil through anti-syphon joints to a self-contained conduit connection box.

It is supplied in combination style with a self-contained disconnect switch; or without a disconnect switch for users preferring to furnish their own means of disconnecting the motor and starter circuit from the power source. The unit is of Type III (weather proof) construction.

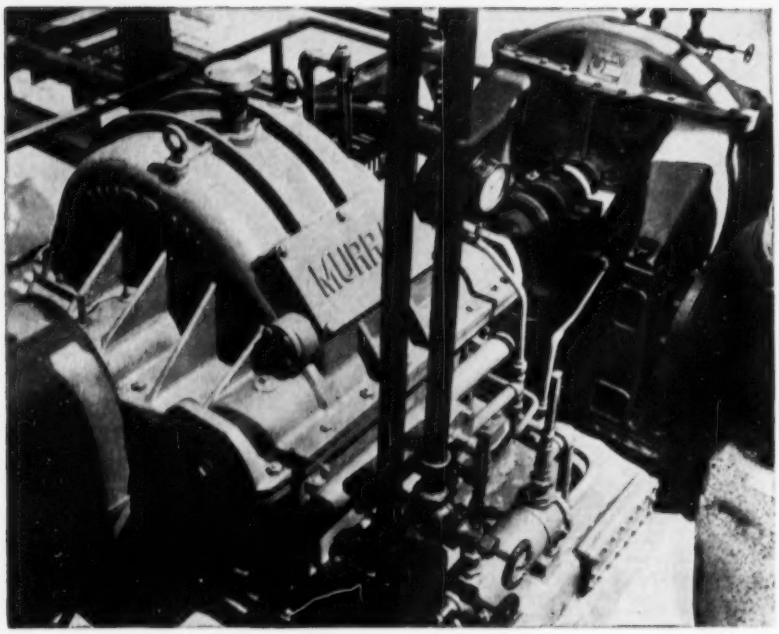
For information on this equipment, just . . .

**Circle E1 on Postcard**

**New Cleaning Gun . . .** A feature of this new solution-lifting gun, recently introduced by Oakite Products, Inc., is the way the cleaning solution is used to protect the operator from the heat of the

steam. The Oakite Hurriclean gun uses a tube within a tube, with steam passing through the interior tube and solution through the other. The steam loses none of its heat, and the cleaning solution re-

# Murray Turbines



One of 4 Murray type U turbo-gear units installed in a southwest rubber plant still giving trouble free service after 12 years in an unprotected outdoor location. This unit drives an Induced Draft Fan requiring 425 HP at 683 RPM. The turbine speed is 3500 RPM.

● Murray turbo-gear units for mechanical drive are right at home in difficult outdoor installations. Fans, pumps, compressors, and many special types of slow speed machines are among the long list of installations powered by Murray turbo-gear units.

Murray gears are of the Herringbone or Double Helical type and all are pressure lubricated at the point of tooth contact.

**MURRAY IRON WORKS COMPANY**

**BURLINGTON, IOWA**

*Builders of Steam Power Equipment for Three Quarters of a Century*

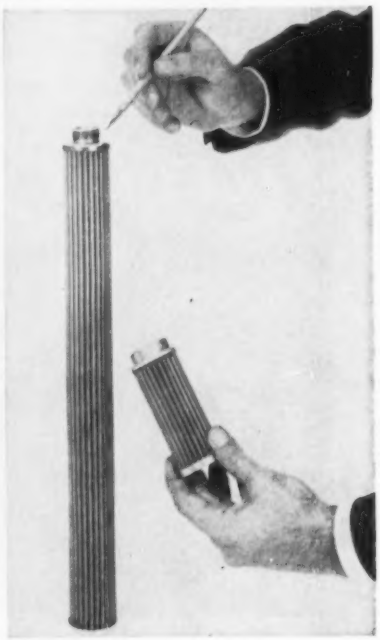

## New Equipment . . .

duces the external temperature of the gun.

Another feature of the new gun is the sealed rotary joint which makes it possible to rotate the nozzle without twisting or wrestling with heavy solution or steam hose. While the forward end of the gun revolves to clean at any desired angle, the handle and hose connections remain stationary. Operator fatigue is further reduced by designing the gun so the thrust of the steam is taken up between the handles.

For details . . .

**Circle E2 on Postcard**



**New Filter . . .** A sintered filter of unique design has been introduced by Purolator Products, Inc. Capable of handling fluids ranging up to 1000 F., the new filter can remove particles as small as one micron in size from a wide range of fluids, including some such "hot" materials as nitric acid, hydrochloric acid, sulphuric acid, phosphoric acid and strong alkylies.

The one-piece element can be made in a variety of diameters and lengths and its radial fin construction can be supplied in specified depths and numbers of convolutions to give extended area within a confined space. Varying flow rates are also available. Filters of stainless steel, monel and other metals can be made as required.

For data just . . .

**Circle E3 on Postcard**

**Ground Indicator . . .** New improvements have been made in the electronic ground indicator developed recently by Gilbert & Baker Manufacturing Company. These have resulted in the indicator becoming the first grounding device approved and listed by the Underwriters' Laboratories.

The indicator is already widely used by petroleum bulk plant and terminal operators and other handlers of gasoline, kero-

# Fittings stay fastened in Corrosive Acid Spray

**PROBLEM:**

Selecting fastenings that would hold pipe fittings together in a unit that is constantly subjected to a hot sulphuric acid spray. Bolts were formerly falling apart in four months' time.

**REMEDY:**

Use of nuts and bolts made of wrought HASTELLOY alloy C.

**RESULT:**

Fastenings made of HASTELLOY alloy C are still holding many months after ordinary bolts had to be replaced.

HASTELLOY alloy C is the most universally corrosion-resistant alloy available today. In addition to aerated sulphuric acid, it has excellent resistance to such strong oxidizers as nitric acid, wet and dry chlorine, and acid solutions of salts. It is available in nearly all standard commercial forms.

For more information on HASTELLOY alloy C, get in touch with the nearest Haynes Stellite Company Office.

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**HAYNES STELLITE COMPANY**

**A Division of Union Carbide and Carbon Corporation**

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- Quiet, vibration-free operation
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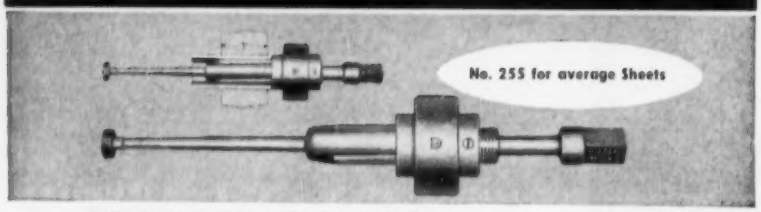
IDEAL

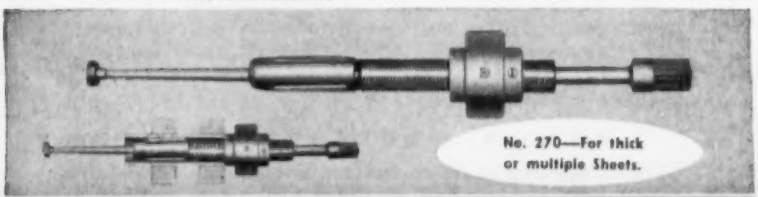
WIEDEKE Precision-Built Tube Expanders




Ball Bearing Adjustable Thrust Collar Tube Expanders are made for Tubes ¼" diameter and larger.
Recommended for use with any Controlled Rolling Motor for uniform expansion of Tubes.

*See your Dealer or write us for Bulletin.*

For Rolling—Heat Exchanger, Condenser and other Heat-Transfer Tubes.

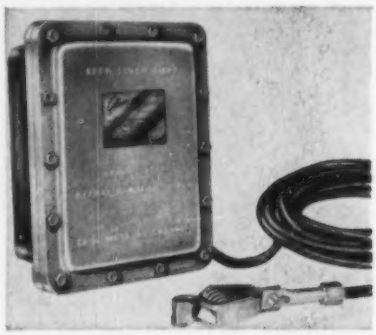



THE GUSTAV WIEDEKE COMPANY

DAYTON 1, OHIO


## New Equipment . . .

sene, fuel oil, alcohols, chemicals, explosives and similar hazardous substances. It provides a positive means of draining

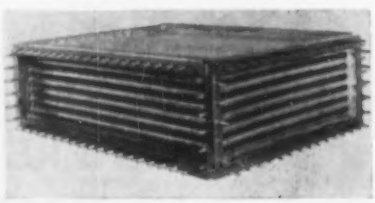


off static electricity accumulated before and during loading and unloading operations of tank cars, trucks and transports. For details . . .

**Circle E4 on Postcard**

**Air-Powered Floodlight . . .** Compressed air turbo-generators power this new 22-pound explosion-proof floodlight designed for use in refinery and other industrial activities where electric power is not readily available. Introduced by Copco Eastern Ltd., the new 150-watt, 12-volt TGB 41 lamp draws 23 cubic feet of air per minute at pressures ranging from 60 to 100 psi. For details just . . .

**Circle E5 on Postcard**



**New Heat Exchanger . . .** A new heat exchanger with a unique finned plate design developed for recovery of heat from high temperature waste gases, is now avail-

# Your children visit a new world each week

Each Thursday, teacher turns a knob and the class enters a new world—a world many are visiting for the first time via the Standard School Broadcast.

Since 1928, this program has introduced man's musical heritage to Western children. Now playing for its second generation, the Standard School Broadcast is probably the biggest "classroom" in history. It has an audience of nearly 1,500,000 listeners throughout the West, Alaska and Hawaii . . . students in 54,000 classrooms and adult listeners at home. They hear a symphony orchestra, a dramatic cast, choral groups and guest artists. Standard provides Teacher's Manuals as program listening guides.

Goal of the School Broadcast is to help listeners gain an absorbing new interest in music, and—through music—a broader knowledge and understanding of the world around them. We suggest that you listen in at home to enjoy the world's best music and to gain one more link with your childrens' interests. TUNE IN every Thursday . . . check your newspapers for time and station.

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# "How To Get Those Top Octanes"

Now available in reprint form, this article by Marshall Sittig and Wayne Warren of the Ethyl Corp., appeared in the September, 1955, Process Issue of PETROLEUM REFINER.

Presented is a thorough treatment of octane improvement techniques, plus a most authoritative and up to date comparison of catalytic reforming processes. Here is a comprehensive, 50-page monograph that should be in every process man's reference file.

Available for only $1.00 per copy, this reprint can be obtained by addressing:

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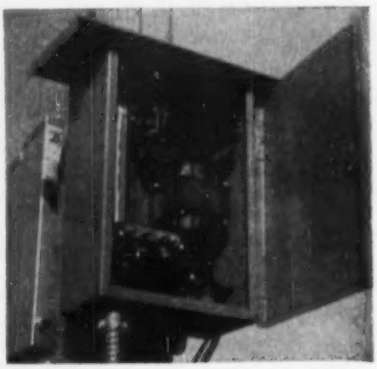
## New Equipment . . .

able from The Griscom-Russell Company. The G-R Plate-Fin Exchanger is designed to withstand gases at pressures up to 100 psi and temperatures up to 1100 F.

Some of the many applications for this exchanger are as a gas turbine regenerator, recovery of stack gas heat for preheating furnace or kiln air, heating or cooling process gas or plant air, and other gas-to-gas services such as vapor-to-vapor exchangers in petroleum processes. For information . . .

**Circle E6 on Postcard**



**Small Rectifier . . .** A new, small corrosion rectifier for low-cost corrosion protection of installations where low amperage requirements are indicated has been developed by Corrosion Rectifying Company. This economy-model rectifier is applicable for corrosion protection of short oil, gas or water pipe lines, heat exchangers, bulk tanks, hydraulic lifts and underground storage tanks in service stations, and for any other buried or submerged metal structures where current requirements for ample corrosion protection are small, and where economy is dictated. For details just . . .

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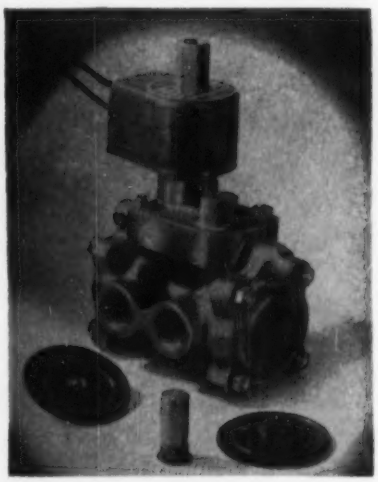

**Three-Way Solenoid Valve . . .** A new packless three-way solenoid valve that operates on a new principle has been introduced by American Switch Company. This new internal pilot-operated Bulletin

# LIFELINE FOR A REFINERY

This thin loop of copper tubing is the mark of a refinery that has learned to combat corrosion and fouling the modern Polyrad way. This is the injection line for Polyrad—and it can well be called the "lifeline" for refinery equipment.

Polyrad is a filming amine that acts both as an inhibitor and detergent. Its detergency maintains throughput, increases heat transfer, and cuts down time for maintenance. At turn-around time you really see the difference—Polyrad—protected bundles are free of corrosion, ready for immediate return to service.

Stocks of Polyrad are maintained throughout the country. A Hercules trained representative will be glad to discuss its application to your specific operating conditions.

*Pine Chemicals Division, Naval Stores Department*

**HERCULES POWDER COMPANY**

*976 Market Street, Wilmington 99, Del.*

**POLYRAD®**

**FILMING AMINE INHIBITOR**



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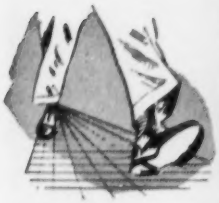
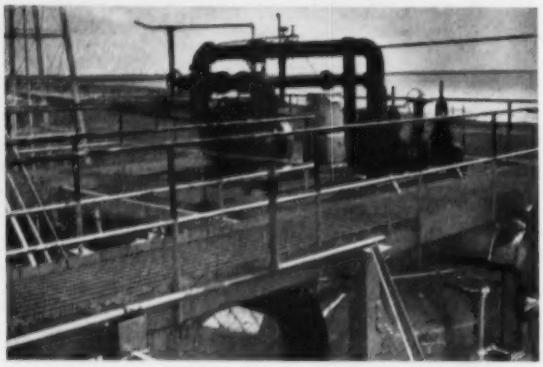
# WHERE SURE FOOTEDNESS COUNTS





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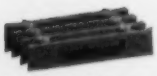
Sturdy, one-piece construction with tops of all bars flush provides open steel flooring and stairs for safe, easier walking. Gary Grating is furnished in a wide variety of neat appearing designs and sizes—and is tailor-made to fit your needs. For complete description and installation pictures on Gary Welded Grating, Stair Treads and Gary-Irving Decking, ask for Catalog PR-16.



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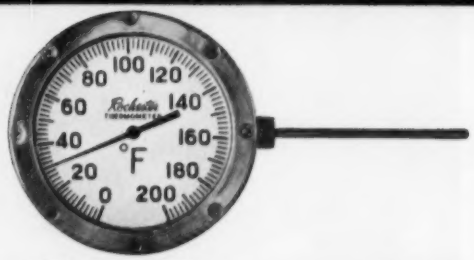


USE

## Rochester Dial Thermometers

Hermetically sealed against moisture and dirt to bring you years of trouble free service.

Recalibrate the dial externally by inserting the stem in liquid of known temperature and adjusting screw attachment.

Designed to be used indoors or out, the stainless steel case is impervious to most corrosive agents.

Rochester Straight-Form Thermometers bring you the added advantage of a stem that can be mounted in any position around the dial.

*For additional information contact your Rochester sales engineer or write:*

Rochester Manufacturing Company, Inc.
38 Rockwood St., Rochester 10, N. Y.
DIAL THERMOMETERS GAUGES AMMETERS


## New Equipment . . .

8316 valve utilizes just three operating parts—two hycar diaphragms and one stainless steel solenoid core. Closely fitted parts that jam, sliding glands and stuffing boxes that leak and require maintenance and stroke setting have been eliminated. Simplicity is further emphasized by the elimination of seat regrinding or lapping. Rated for 250 psi on liquids and gases, the valve is available in ⅜-inch and ½-inch pipe connections. For detailed information

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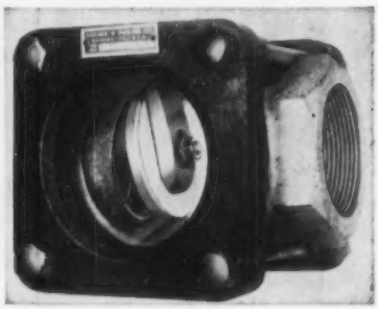


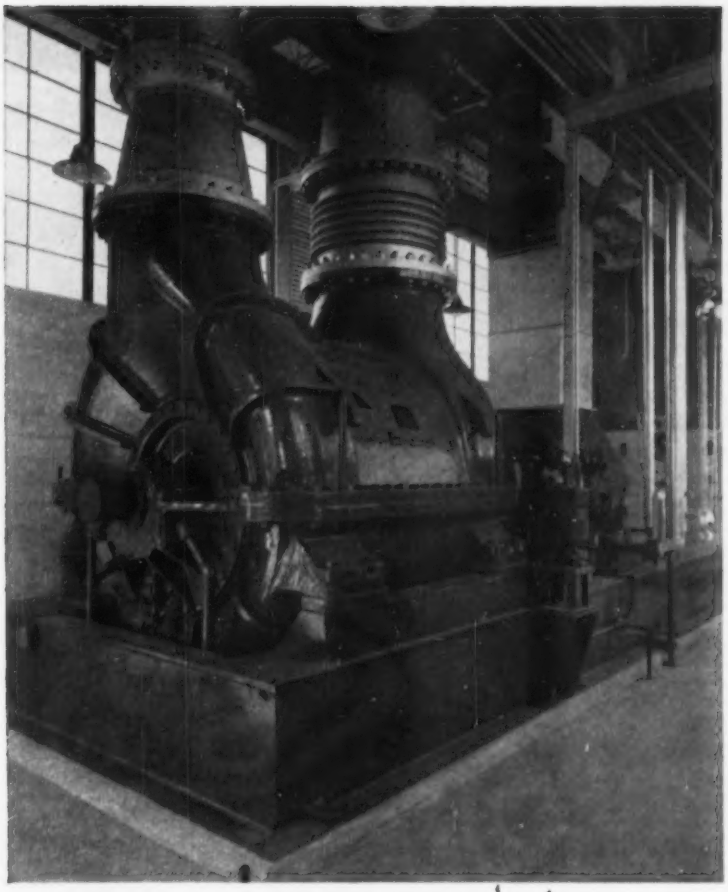
**Check Valve Sight Flow Indicator . . .** Fischer & Porter's Bull's Eye Check Valve Indicator is the first sight flow indicator to combine flow indication with positive check of back-flow. The self-aligning flapper seats securely over the entrance if back-flow occurs. Two ½-inch thick windows give good visibility of flow. For further details . . .

**Circle E9 on Postcard**

**New Plate Clamp . . .** The Porto-Magnetic Plate Clamp is a lightweight, self-contained unit, combining a powerful magnetic base and a fast operating jack. Butt welding steel plate by a single operator is easily accomplished. The Porto-Magnetic Plate Clamp is first placed with the jack over the warped plate. A few finger tip turns of the ratchet lever gets alignment results. For more information . . .

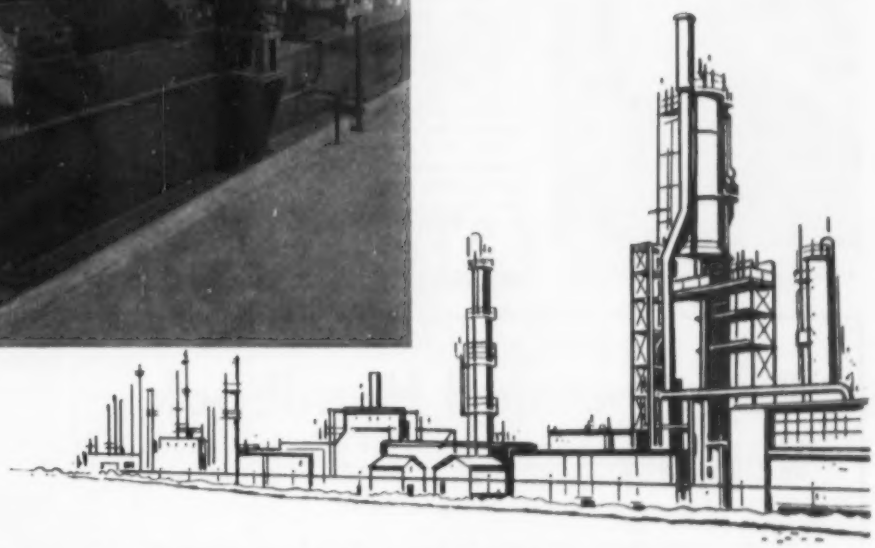
**Circle E10 on Postcard**

**New Line of Truck Cranes . . .** Five new truck-crane models, ranging from 12½ to 35-ton lifting capacity, are now being offered by Link-Belt Speeder Corporation. All of the new models feature power hydraulic controls which permit the operator to control all working operations with a "flick of the wrist." The new models have



# I-R BLOWER

## supplies 28,000 cfm for New Cat Cracking Unit



## at CONSUMERS' COOPERATIVE REFINERIES LTD.

● Newest addition to the Regina, Saskatchewan Refinery of Consumers' Cooperative Refineries, Ltd., is a catalytic cracking unit that raises plant capacity from 6,500 to 12,000 bbl of crude oil per day.

Air for the new cracking unit is supplied by the 28,000 cfm Ingersoll-Rand blower shown above. Driven by a 3,000 hp induction motor with speed increasing gear, the blower operates at 5,000 rpm, 13.6 psia intake and 36.8 psia discharge pressure.

In refinery processes such as this, shut-downs are costly and *dependability* of equipment is vitally important. Ingersoll-Rand Turbo-Blowers and Turbo-Compressors have achieved an enviable record of trouble-free service in hundreds of installations at leading refineries and process plants the world over. That's why it will pay you to specify Ingersoll-Rand equipment for the compression, transmission repressuring and circulation of air and gases.

12-252

Ingersoll-Rand

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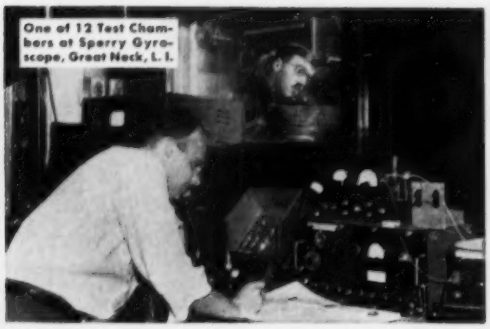
For more data on advertised products, use Readers' Service Cards, last page.

These Special Frick Cooling Coils Are Making History by Cooling Synthetic Rubber Twice as Fast



One of 12 Test Chambers at Sperry Gyroscope, Great Neck, L. I.

# Need a SPECIAL Cooling System?

Orange Juice is Concentrated with Frick Reversed Refrigeration at 1/10th the Cost of Steam.

**Then the chances are that Frick engineering and production facilities can serve you.**

**We specialize in custom-built refrigerating and air conditioning equipment: our engineers, designers, foundrymen and mechanics team up to handle those unique jobs which other manufacturers hesitate to accept.**

**We just furnished, for example, a 25-foot shell, over 7 feet in diameter, with complete equipment for conditioning air at 100 pounds pressure for a huge wind tunnel.**

**Tell us what you need—we'll do the rest! Branches and Distributors in principal cities, the world over. Write**

DEPENDABLE REFRIGERATION SINCE 1882

FRICK CO.

WAYNESBORO, PENNA. U.S.A.



# Petrochemical Handbook Reprint

Now available in reprint form, the Petrochemical Handbook Section of PETROLEUM REFINER'S December, 1955, issue contains graphic data on:

**80 manufacturing processes**
**10 separation processes**
**. . . of the most interesting Petrochemicals**

Here's your chance to add to your library the latest job help information on petrochemicals. Available for only $1.00 per copy, you may obtain this reprint by addressing:

**REPRINT DEPARTMENT**

**PETROLEUM REFINER**

**P. O. BOX 2608, HOUSTON 1, TEXAS**


## New Equipment . . .

power hydraulic operated clutches that are self-compensating for heat and normal lining wear. They are fully convertible to standard front end attachments, and are

available with torque converter power units. All are mounted on specially designed carriers with full-floating walking beam rear axle supports that allow travel over uneven terrain. Also available are screw-type outrigger jacks and pontoons, and removable rear outriggers.

For details just . . .

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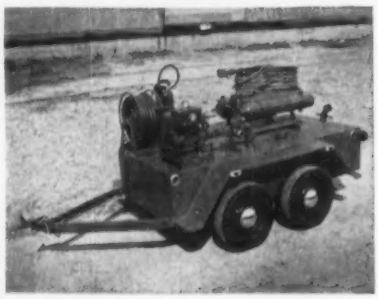


**A New Firefighter . . .** The Paris Firefighter contains everything required to fight a fire. It is available from Henry H. Paris Distributor, Inc.

Mounted atop a trailer body are a high-volume, high-pressure pump, hose reel, 100 feet of 1-inch high-pressure hose, 150-pound dry-chemical tank with 50 feet of hose, 30-pound extinguisher, valves and controls. Thirty feet of 2½-inch suction hose is carried in a special compartment at the rear of the trailer.

The valve and piping arrangement is such that in addition to pumping water from the trailer tank, water can be picked up from a pond, reservoir, roadside ditch or directly from a fire hydrant. Water can also be taken from these sources to fill the tank.

For full information . . .

**Circle E12 on Postcard**

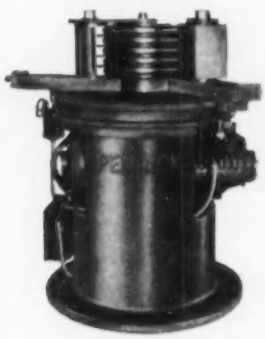
**Modular Furnace Walls . . .** Geo. P. Reintjes Company has announced a modular-suspended wall. It is made in 3-inch, 4-inch, 6¾-inch and 9-inch widths, to meet conditions normally met in the heaters and

# extra!

**ALL ABOUT THE LATEST BENDING METHODS**

Let Pedrick show you how the latest methods of bending pipe, tube and structural metal—on a job or production basis—can save you money.

For full information on Pedrick Production Benders, write PEDRICK TOOL AND MACHINE CO., 3640 N. Lawrence St., Phila. 40, Pa. Dept. 9.



FREE "PEDRICK LINE" BULLETIN. WRITE TODAY.

**PEDRICK** production benders

# The VIKING

**GEAR-WITHIN-A-GEAR**
**Rotary Pumping Principle**

. . . operates equally well in either direction.

. . . for all grit-free liquids.

**We invite your inquiries**

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MANUFACTURERS • MACHINERY FACTORS • CONTRACTORS

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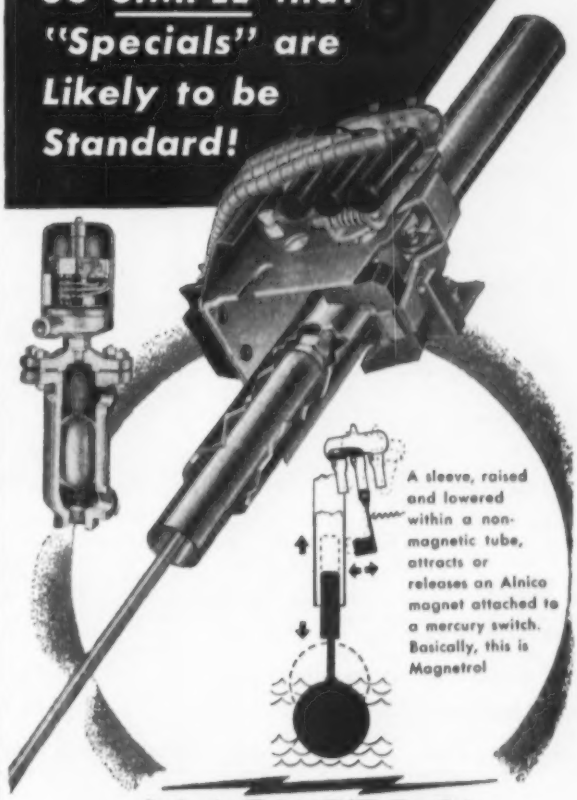
# So SIMPLE that "Specials" are Likely to be Standard!


A sleeve, raised and lowered within a non-magnetic tube, attracts or releases an Alnico magnet attached to a mercury switch. Basically, this is Magnetrol

# MAGNETROL

*The World's Most Dependable*

## LIQUID LEVEL CONTROL

Because of the utter simplicity of Magnetrol's magnetic operating principle, standard models can be easily adapted to meet any special requirements for pressure, temperature or corrosive liquids . . . and usually at little extra cost. This Magnetrol versatility has solved all kinds of tough level control problems . . . and given our engineers wide application experience that can be invaluable to you.

Magnetrol is so simple that failure is all but impossible! Using only permanent, unfailing magnetic force for its operation, there's nothing to wear out . . . no diaphragms or bellows to stiffen and rupture . . . no electrodes to short or corrode . . . no packing to bind or leak. Magnetrol is practically maintenance-free! Magnetrol units are available for controlling level changes from .0025-in. to 150-ft. . . . with multi-stage switching when desired. Send coupon for full details.

**MAGNETROL, Inc.**

**Send Coupon For Full Details**

**Magnetrol, Inc., 2112 S. Marshall Blvd., Chicago 23, Illinois.**

Please send me catalog data and full information on Magnetrol Liquid Level Controls.

Name _____

Company _____

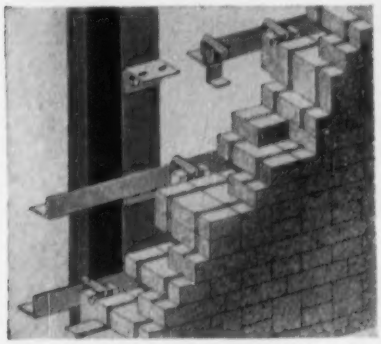
Address _____

City _____ Zone _____ State _____

## New Equipment . . .

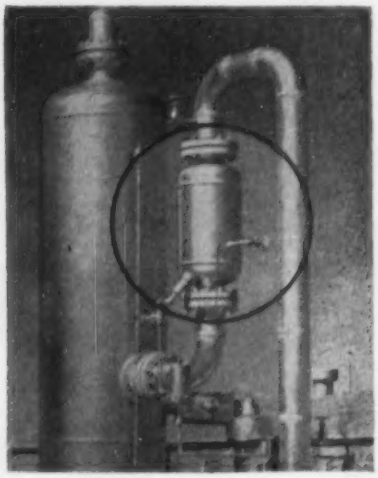
boiler furnaces of refineries. The construction of the new Reintjes wall is modular, the module being a 2½ x 4¼ x 9-inch brick.

The walls can span from buck stay to buck stay regardless of whether they are located 5 feet or 10 feet apart, the difference being the size of the angle used. From the illustration of this construction, note that the castings loosely hang over the vertical leg of the angle. The supporting tile rests on the lower leg of the casting and is hooked into the top of the tile in much the same manner as you would cup your hand. For complete details . . .



**Circle E13 on Postcard**

**Gas Scrubber** . . . A new low-cost Purifier has been developed by V. D. Anderson Company for use in gas scrubbing. This purifier, called Hi-eF Type L, is said to recover virtually 100 percent of the recoverable liquid present in natural gas. The Purifier separates all liquid and mist entrainment from butane, methane, propane and other hydrocarbon gases by means of a two-stage principle of separation. The first stage of separation employs carefully controlled impingement against a baffle which removes the larger droplets of entrainment from the gas. In the second stage of separation, the Purifier removes the fine mist entrainment by utilizing controlled centrifugal action. For further information . . .

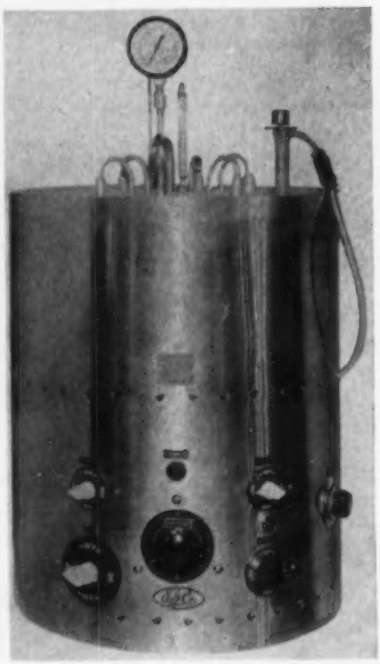


**Circle E14 on Postcard**

**Plug Valve Operator** . . . A new self-contained gas-operated double-acting actuator for remote operations of plug valves and similar mechanism, has been introduced by Bettis Corporation. Called the Robotarm, the device basically is a diaphragm separating a large and small air chamber where the front chamber, being the larger, is used to act as an accumulator. Check valves are built into the diaphragm assembly to pass air between the two chambers. A rod connected through the packing gland to the diaphragm extends from the larger chamber to operate necessary driving mechanism. For plug valve operation the connecting rod works as a closed rack and gear assembly furnished to fit compactly over each type of valve.

Fail-safe operation is assured, and instrument line piping is minimized. The device requires 15 to 100 pounds pressures to operate. For additional information, just . . .

**Circle E15 on Postcard**



**Fuel-Gum Tester** . . . An aluminum block apparatus for determining existent gum in fuels by jet evaporation has been introduced by The Emil Greiner Company. This constant temperature bath is suitable for determining existent gum in aviation and motor gasoline using air pre-heated to a temperature of 320 F. or for jet fuels using steam as the vaporizing medium at a superheated steam temperature of 450 F. For full information . . .

**Circle E16 on Postcard**

AURORA
Always
PUMPS
"TOPS" by EVERY TEST
Capacities to 150 G.P.M.
Heads to 600 Ft.
APCO Two Stage Pump for High Pressure Service
APCO is the highest development of the Turbine-Type Pump. Unsurpassed for small capacity high head duties. Handles non-lubricating liquids almost indefinitely without wear. Suited to "1001" duties. Write for Bulletin 111 or Condensed Catalog "M".
STAINLESS STEEL APCO PUMPS
We carry representative sizes of APCO's in stock in No. 316 Stainless Steel for prompt shipment.
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AURORA® PUMP DIVISION
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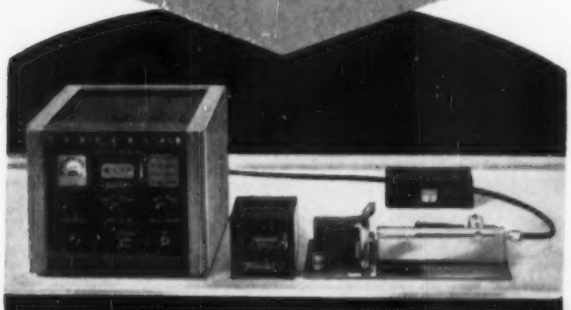
fast! simple! accurate!

**determination of sulphur in hydrocarbons**



Tracerlab's sulphur determination apparatus enables you to use the fastest method to determine accurately the sulphur content of hydrocarbons such as fuel oil and gasoline. With this new Tracerlab equipment, unskilled operators can determine sulphur content quickly, easily, precisely. Hence, sulphur determination can now be put on a wholly routine basis.

No longer is it necessary to employ complex X-ray diffraction apparatus and highly skilled, technically trained operators. The new Tracerlab equipment is compact, rugged and can be conveniently used in the field or the refinery with no need for a controlled laboratory environment. It operates on the principle of selective absorption of low energy radiation from an isotope source.

The equipment is low in first cost and can be completely amortized over a short period. Your inquiries are invited. Send for Bulletin P-104.

*Tracerlab*

130 High Street, Boston 10, Mass.
2419 South Boulevard, Houston, Texas
2030 Wright Avenue, Richmond 3, Calif.

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**A Specialized Engineering Service to STOP**

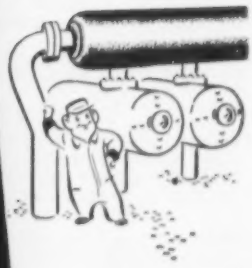
**NOISE—**

—from intake or discharge of air, steam or gas piped to atmosphere.
—from engines, compressors and vacuum systems.

and

**PULSATION—**

—from surges created by compressors, pumps, blowers and pressure reduction systems.



The Burgess-Manning Snubbing Principle has, for many years, been engineered to varied problems of noise and pulsation in every branch of the petroleum, chemical, power and general industries. Noise and pulsation has been completely eliminated—production has been greatly increased, maintenance reduced with neighbor and labor relations improved.

Here is an engineering service, backed by years of experience and a proved principle of snubbing that will prevent and eliminate noise and pulsation problems.

***We invite you to present your problems for recommendations.***

***Write*** for your copies of case histories of representative installations and see the results for yourself.

BMM Sound Engineering

BURGESS-MANNING COMPANY

711 East Park Avenue, Libertyville, Illinois
Dallas, Texas



For more data on advertised products, use Readers' Service Cards, last page.

Dependable

# Bucyrus-Erie cranes hold down plant maintenance costs

Thoroughly reliable, easy-to-service Bucyrus-Erie lifting cranes give you the high degree of availability you need for efficient handling of plant maintenance problems. Simplicity of design is one big reason.

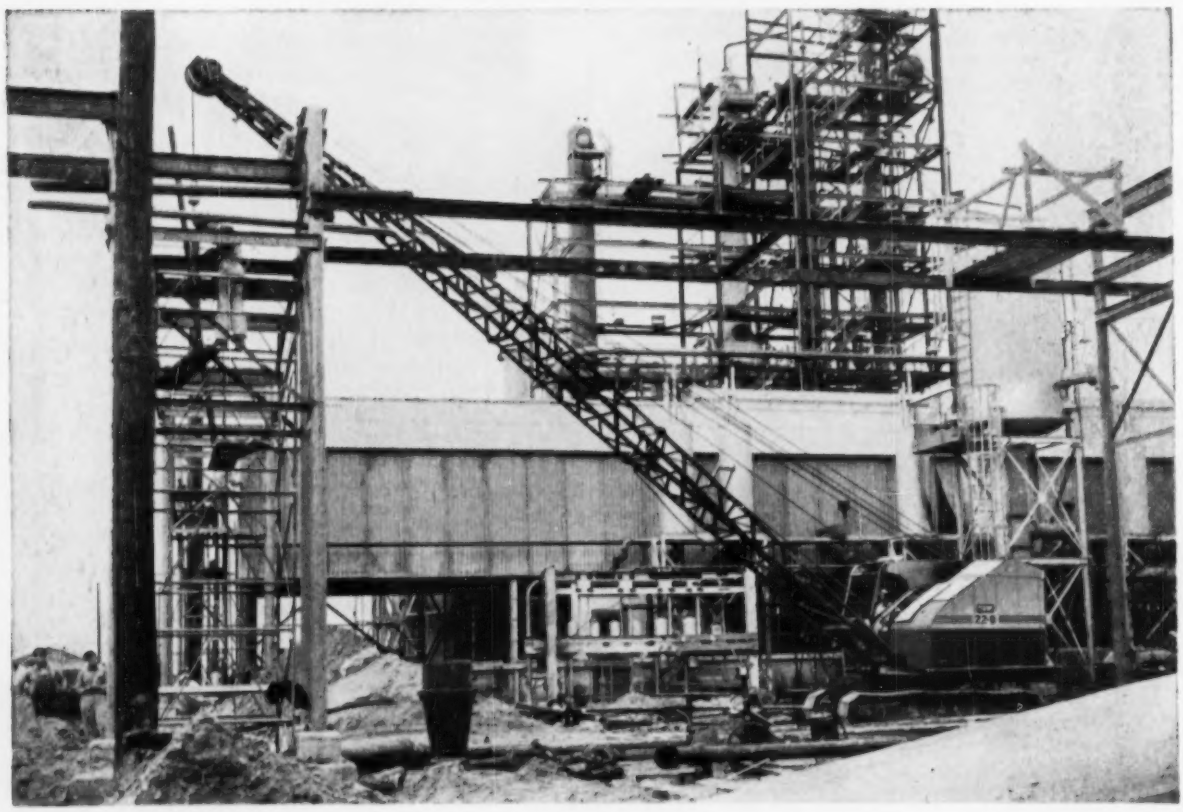
The entire machinery layout is specially designed to provide free accessibility for servicing. To work on one part you don't have to remove two or three others first. Main shafts are placed side by side, not stacked up vertically, so that it's easy to get at the brakes and clutches.

There are many other Bucyrus-Erie headline features that add up to a higher percentage of actual working time each day — that help you hold down plant maintenance costs. Get in touch with your Bucyrus-Erie distributor now for the full story. There are eight crawler-mounted cranes in the Bucyrus-Erie line — lifting capacities depend on length of boom, size of crawlers, and counterweight. Also investigate the 15-ton Model 15-B and 25-ton Model 22-B Transit Cranes — carrier-mounted to provide rubber-tired mobility. All cranes are fully convertible to excavator operation.

161E55

BUCYRUS ERIE
South Milwaukee Wisconsin

75 YEARS OF SERVICE to Men Who Shape the Earth



# What's New in Manufacturers' Literature

**For more data on New Equipment or copies of Catalogs and Literature reviewed in this issue, use the Reader Service postcards just inside the back cover and facing the Advertisers Index. Simply circle code numbers of items desired—sign and mail card. Requests are transmitted to the manufacturer as soon as received by us for mailing of desired information directly to you.**

**Scanning and Logging System** . . . The Taylor Instrument Companies has introduced a new scanning and logging system. It is a compact intelligence center which coordinates all related process data, enabling the operator to instantly visualize, evaluate, and act upon every processing irregularity as it occurs—without leaving his desk in front of the panel. This, in addition to the most modern techniques in scanning and logging. This new system, known as the Taylor Trans-Scan-Log System, compactly summarizes all of the processing data on a section of graphic panel and an adjacent panel of miniature indicating and recording receivers.

The graphic panel section, because it does not have to provide space for the insertion of indicating or recording receivers on the diagrams of the processing units or process lines, can easily compress a normal 20-foot graphic panel into a 5-foot section. The instrument panel requires only enough space to accommodate the fronts of the indicating and recording receivers. Numbered lights on both the graphic panel and its corresponding indicator or receiver instantly relate one to the other.

To get the company's 14-page Bulletin 98268, just . . .

**Circle E17 on Postcard**

**Pressure Cells . . .** SR-4 fluid pressure cells and their uses in electrical measurement and control of pressure are presented in a new 16-page Bulletin 4306, issued by Baldwin-Lima-Hamilton Corporation. Six standard types of cells in 25 sizes ranging from 15 to 50,000 psi., as well as some special purpose cells, are included. Characteristics, principles of operation, instrumentation, and specifications are given. For your copy . . .

**Circle E18 on Postcard**

**Reformer Data . . .** The Kellogg naphtha reforming process using the Sinclair-Baker platinum catalyst for the production of low cost, high octane reformates is described in detail in a new 8-page booklet just issued by The M. W. Kellogg Company.

Quick start-up, a readily regenerated catalyst with long life, adaptability to low grade naptha feeds, and high octane levels are features covered.

As explained in the booklet, experimental operation of the process is reduced to a minimum. One reforming unit was started on its final test run within two weeks after catalyst was first charged to the reactors—with octane rating and yield during this 15-day period well in excess of the guarantee.

**Circle E19 on Postcard**

**Tank Storage . . .** Principles of venting flammable liquid storage and process tanks for effective operation, fire protection and low-cost maintenance are completely described in a new 12-page booklet from Protecto Seal Company. The application of each principle is explained clearly and concisely.

There are sections on flame arrester units for safeguarding storage tank fill openings, and safeguarding rodding and sampling operations. For your copy of this bulletin . . .

**Circle E20 on Postcard**

**Process Data . . .** A unique steam-pyrolysis process which allows the refiner to dispose of marginal products by economically converting natural gasoline, residuals or other low value materials to ethylene and olefins, is the subject of a new eight-page booklet published by The M. W. Kellogg Company.

As shown in the booklet, Kellogg steam-pyrolysis results have been marked by excellent yields of high purity olefins, in most instances higher than can be achieved by conventional cracking.

The process has a proven high on-stream efficiency. In over three years of commercial operation, the on-stream efficiency of the Kellogg process has averaged about 95 percent.

The booklet covers typical yields from the steam cracking of ethane and propane, includes a flow chart and process description of the steam pyrolysis design, and features an overall economic summary of an operating plant, highlighting total manufacturing costs with various feed stocks and total direct operating costs.

Copies of this booklet are available . . .

**Circle E21 on Postcard**

**Closed Tank Level Measurement** . . . Just issued by The Foxboro Company is a new 8-page bulletin, 13-22, describing closed tank liquid level measurement and control with the recently announced Type 13 LA d/p Cell Liquid Level Transmitter.

The Type 13 LA is essentially the same as the force balance differential pressure flow transmitter, except that a simple range suppressor spring has been added to the basic mechanism. The spring balances out the effect of hydrostatic pressure in the piping line from the high point of the tank. Transmitter is fully adjustable for measurements up to the equivalent of 250" of water without change of parts.

For complete information . . .

**Circle E22 on Postcard**

**Organic Chlorine Compounds . . .** A new 48-page book, "Organic Chlorine Compounds," has just been published by Carbide and Carbon Chemicals Company, a division of Union Carbide and Carbon Corporation.

The book discusses the applications of 18 products, their solvent properties, and their proper handling and storage. It includes important data on physical properties, specifications and test methods, shipping information, and constant boiling mixtures. Fourteen charts contain useful physical property data.

Copies of this new book "Organic Chlorine Compounds," (F-4769) are available. Just . . .

**Circle E23 on Postcard**

**Process Pump Bulletin** . . . Ingersoll-Rand's new 20-page, two-color process pumps bulletin, fully describes vertically split, single-stage and two-stage type process pumps.

In this bulletin are design features of the pumps, dimension tables, cross sectional and installation views, plus a two-page chart showing the extensive interchangeability of parts through the entire line of pumps.

These units are built in accordance with latest API specifications. The range of coverage is from 1 to 8 inches including capacities to 3200 gpm, heads to 925 feet, at temperatures to 800 F.

For copies of this new bulletin, Form 7094-B.

**Circle E24 on Postcard**

**Steam-Jet Ejectors . . .** The selection of single and two-stage stock ejectors for general vacuum service is described in a new handbook on Steam-Jet Ejector Applications by Worthington Corporation.

Contents include application ranges and selection tables on single, and two-stage stock ejectors, dimensional and installation data, and information on sections and parts lists.

The new 60-page manual includes an engineering reference section designed to familiarize the reader with ejector terminology and the principles and procedures of ejector selection and application.

For further information or copies address requests direct to Worthington Corporation, Advertising & Sales Promotion Department, Harrison, N. J., specifying Bulletin W-205-E21.

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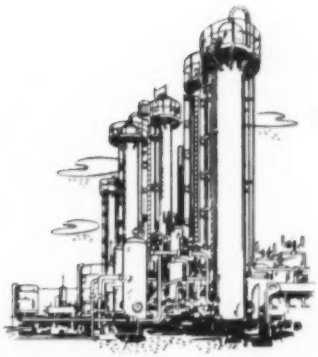

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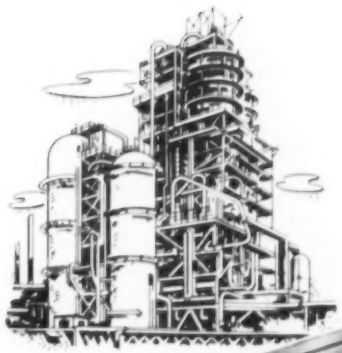

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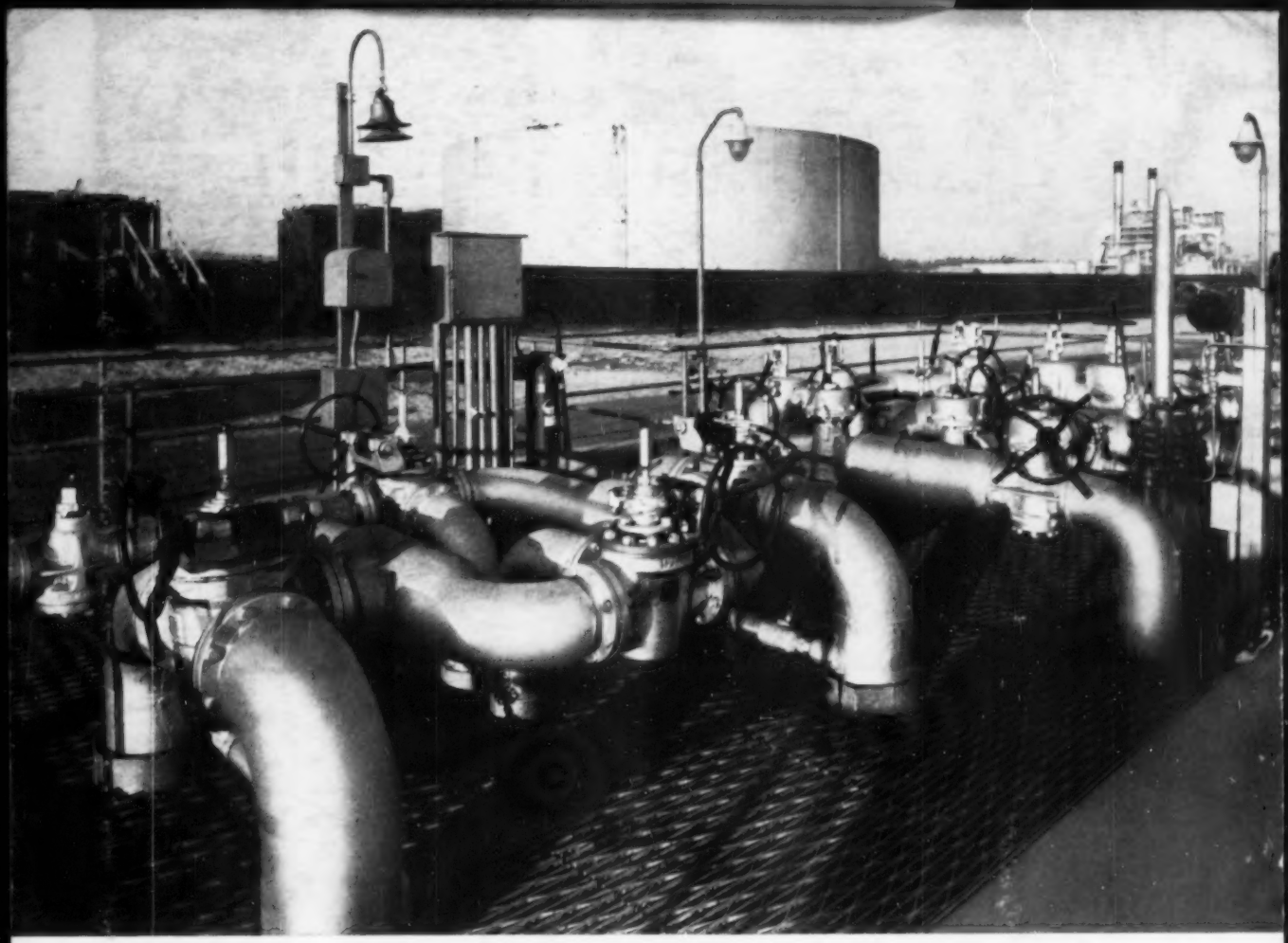

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